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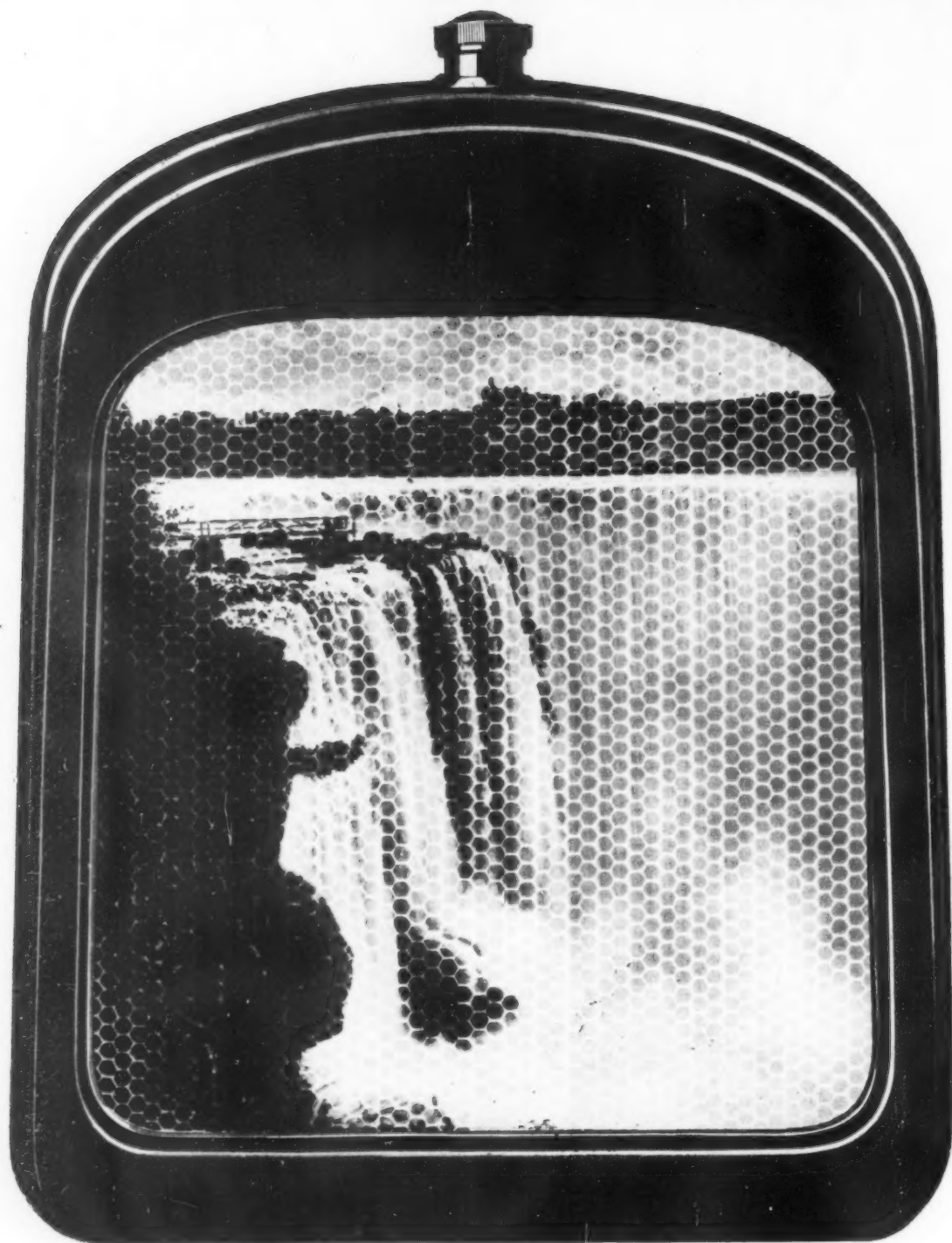
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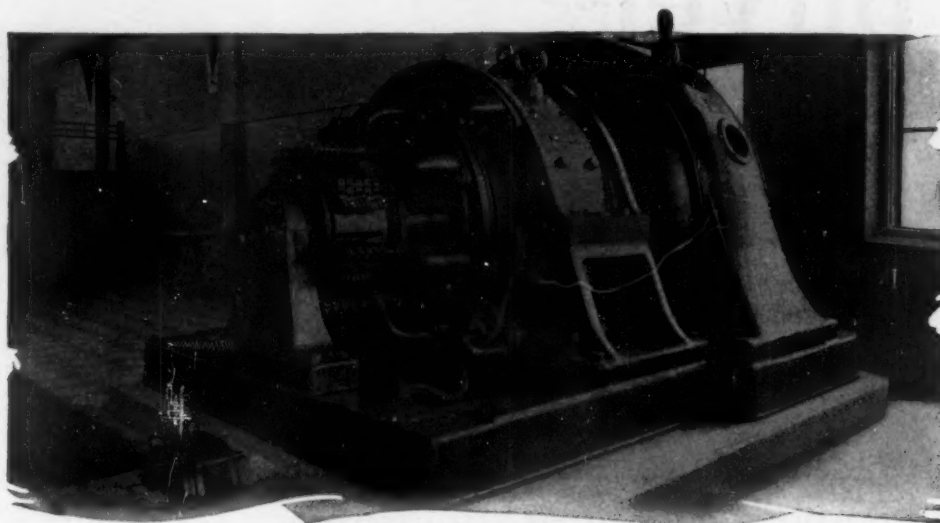
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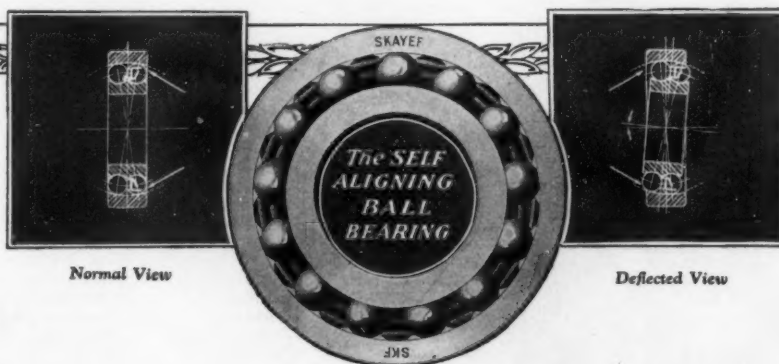
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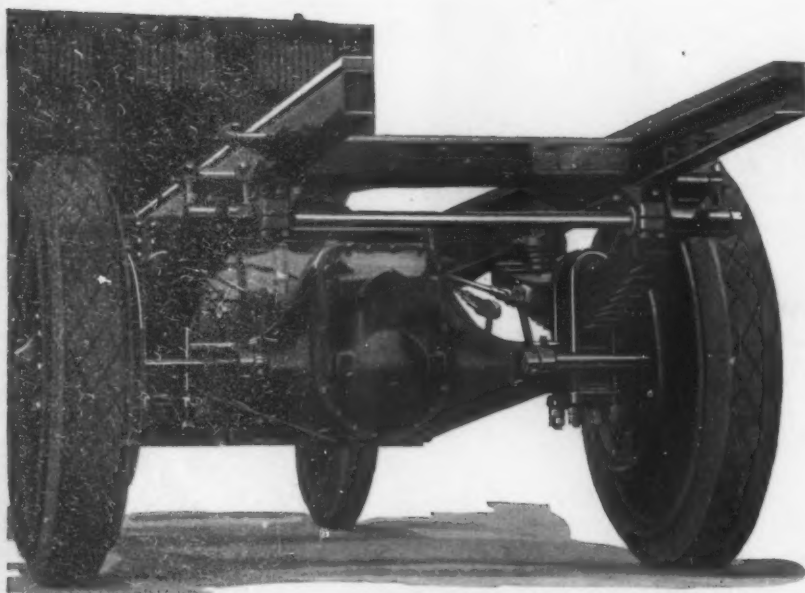
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FROM coal tar products to the sky by day; from a study of the earth's crust to fighting the bed bug; from the color in nature to the War Department's radio net; from the safety of life and limb to the handling of snowslides; from the largest map in the world to the rôle of birds in sewage disposal; from the fascinating story of the criminal as an inventive mind to the serious study of fire risks; from Uncle Sam's high-priced forestry school to the imposing span of the proposed Sydney Harbor Bridge; from the open hearth furnace of the steel works to the locomotive of the future; from the speculative subject of telepathy to the intricacies of the Abrams technique—all these widely diversified subjects, found in this issue, come within the editorial scope of this journal. And this editorial scope continues to expand year by year as new fields are thrown open to science.

ALL scientific information is interesting, but perforce some kinds of scientific information are more interesting than others. There is bound to be a more fascinating story in the inventive genius of the criminal than in the compounding of some new paint. And after all, our object is to be most interesting and always readable, without sacrificing for a single moment the authenticity of the facts thus presented. That truth which is stranger than fiction finds expression in our columns; and that truth which is strangest and most interesting finds the greatest amount of space for its proper treatment.

THUS many of the happenings in the various fields of science are chronicled in these columns in the form of notes. Lest that vast fund of useful information tucked among the advertisements at the back of every issue be overlooked, because of the more readable and obviously more attractive illustrated material, we call attention to it at this time. Month after month a member of our staff goes through the current trade papers and technical journals and bulletins which come into our hands in a never-ending flow. Those bits of information which are of value to the SCIENTIFIC AMERICAN—that well-rounded-out man whose knowledge of practical things makes him sought in the circles of everyday commerce and intellectual social life—are digested into short, understandable abstracts the bulk of which appear under the heading of "The Scientific American Industrial Digest," while others of a non-industrial character are scattered throughout our columns. Professor E. G. Spaulding of Princeton University, one of our contributing editors, abstracts for us the more interesting articles appearing in domestic and foreign journals devoted to pure science. Our Chemical Editor, Mr. I. Ginsberg, reports new chemical products and processes described in the chemical press of the world, in his "Service of the Chemist" department. All these abstracts represent far more editorial work than their space allotment would indicate, and they are the very quintessence of information.

OUR psychic article for April, we must confess, was prepared and published with some misgivings. Would it be possible to say enough without saying too much? Would it be possible to offer additional inducements for high-grade mediums to come forward, without making it appear that we were flinging a final challenge into their teeth? Apparently both these things were possible; for in all the comment which we have had from this

article nobody who has taken the trouble to write to us has read into our words more than they were intended to convey. A sincere regret that we had got no further than we had, a sincere determination to do all we could to insure that the last half of our investigation should be less barren of results of permanent scientific value than the first half—that was all we meant to convey and that, judging from the returns is all we did convey.

ALREADY, we are in a position to insure our readers of action as a result of our enlarged offer. Already, indeed, we are in the position pictured by the concluding sentences of our April article—that of being obliged to tell all applicants that, for the moment, the offer is in a condition of acceptance, and that for the moment no arrangements can be made with further candidates.

OUR July issue will contain the first of what we believe will be a fairly extensive series of articles dealing with the mediumship which will come immediately before our committee as a result of our extended offer. We have known of the case for some time and have in fact been in rather close touch with it. The medium is in every sense of the word a private and non-professional one. She has never sat save for her family and her friends, with the occasional introduction of a small group of privileged investigators. She is a person of a social and intellectual and financial standing which make it necessary to appraise the moral factors in the case at a very high value, and to take the claims which are made on her behalf with the greatest seriousness.

THE case has a very considerable history prior to our participation in it, which is so much a part of the story that we plan to tell it at some length. Just as in the cases of Nino and his predecessors we had to explain in detail what the mediumship was supposed to consist in, we must do the same for our newest applicant. And in her case the story is so much longer, must be told in such greater detail, and must have so much more serious attention, that we have decided, in the July issue, to attempt nothing more than this. We shall by that time have had test sittings, but they will have to wait for the August and later issues.

IF YOU have been impatiently skimming these lines in the expectation of learning the identity of this medium whom we take so very seriously, you are doomed to disappointment. Publicity is the last thing in the world which she wants. She will remain anonymous right down to the moment when, and if, she wins our money; and even after that, if a valid way can be found of making it plain that the case is as represented, her identity will be concealed. We shall not even tell you, for the present, where she lives or where our sittings with her are held.

JUST to whet your curiosity a little more sharply, however, we will tell you so much more: If she wins our \$2500, it is to be devoted entirely to paying the expenses incidental to bringing before us other mediums, for further investigation. We shall have more to say of this aspect of the case next month; we mention it here in passing, just to put emphasis upon the financial disinterestedness of the lady who is trying to prove to us that the objective phenomena of the seance room occur.

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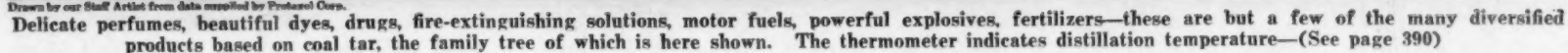


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SCIENTIFIC AMERICAN

NEW YORK, JUNE, 1924.



Inside the Earth, and Out

Conditions in the Rock Crust That Lead to Earthquakes

By Sir Oliver Lodge, F.R.S.

THE old view about the earth was that it consisted of a thin crust of solid material containing a seething and molten interior, which at intervals burst forth in volcanoes and streams of molten lava. At one time indeed exaggerated views were held about the thinness of the solid crust; but more conservative estimates placed its thickness at about 800 miles. There was no evidence for this, however; the guess was due to the steady increase of temperature experienced as borings were made into the crust, so that it could be reckoned that a temperature that would melt the rocks was to be expected at a reasonable depth.

The idea of a molten or really fluid interior had to be abandoned when the great natural philosophers of the last century began to study with precision the phenomenon of tides. The tides affect only the fluid part of the earth, and practically are found to affect only the ocean, showing that that is really the only fluid portion, in the full sense of the word "fluid." The rest of the earth must be extremely rigid; otherwise the tidal forces would affect that too, and the whole earth would bulge, instead of only the liquid ocean at its surface. The yield of the ocean is a differential one. If the whole earth yielded appreciably, the extra yield of the ocean as observed, would not occur. Consequently, measurement showed that the earth must be as rigid as glass or steel; and it was also pointed out that rocks under the pressure of the superincumbent materials could not melt, however hot. They have to expand on melting, which is the opposite of ice; and therefore great pressure would keep them solid in spite of high temperature. Moreover, it was realized that volcanoes could not be a sign of really deep-seated fire. If the earth were mainly molten, the crust would be likely to break up and sink in, and the fluid come to the surface; in fact, the earth in a molten stage would not be habitable at all. Ice floats on water; but solid rock does not float on molten rock, it sinks.

This state of things may really have occurred at a certain early period of the earth's history; but it would not become habitable until this process had all ceased, and the crusts formed by cooling had successively fallen in, until the whole earth was solid, when it would have a chance of cooling at the surface sufficiently to allow water to accumulate and low forms of life to make their appearance; and this cooling has gone on until today. Volcanoes and hot springs were therefore spoken of as mere skin eruptions, localized pockets of heat; which subsequently could be readily explained by radioactivity, that is to say, by the spontaneous disintegration of heavy atoms and evolution of some small part of their immense stores of intra-atomic energy.

Indeed, this phenomenon of radioactivity—which is also held to account for the astonishingly high temperature of the sun and the stars, and to be the supply of the heat which they are continually radiating—is so great that the wonder was that the earth was not hotter than it is. Hence, no one doubts that the interior of the earth is hot; but everyone doubts that it is seriously fluid. But if not fluid, it may be pasty, that is to say, extremely viscous. Ordinary viscosity is dis-

played by such fluids as honey or treacle; but there is a kind of fluidity which behaves like a solid to quick forces, and as a fluid only to very slow ones. The most familiar example of that is pitch. Pitch when cold behaves like a brittle solid; it can be broken with a hammer, and does not bend or otherwise yield to ordinary forces. But it is found that if even a small force is applied to it for months together, it yields to that force, very slowly, in the same sort of way that a fluid would yield to it quickly. A fluid takes the shape of any vessel you put it into, and flattens out under its own weight. So does pitch, no matter how cold it is; but you might have to wait several years for the process to be complete. It never yields quickly. A force lasting only a day or two would make hardly any impression, provided it was not sufficient to cause breakage.

Now there is a certain heavy black rock which is rather prevalent in the deep crust of the earth, and which when it comes to the surface is known as basalt

of the coast the sea is encroaching, or the land is sinking. But the operation is much more striking on a large continent like America. Take South America for instance. It is floating in equilibrium, with a high range of mountains, the Andes, on the west, and the great river plains of Brazil and Argentina on the east, and if left to itself would be in equilibrium; but the rivers keep on carrying down material from the mountains to the sea, and hence, though very slowly, are gradually disturbing its balance, like a load shifted from one side of a boat to the other. Consequently it is to be expected that the east side is gradually sinking, and the west side gradually rising—a slow and very slight rotation of the whole continent.

But what is the result? It is evident that a great strain must be put upon the solid materials of the continent especially at the edges. The tilting of a mass like that must be accompanied by sudden fractures and slips. The solid portion will be strained until it gives way and falls suddenly back. Such breakage is most

likely to occur where the ground is being forced up. Parts of it will cling on until they can cling no longer and then fall with a smash, and very likely a splash, since the breakage may easily occur under the sea at some little distance from the coast. Hence, it is that the coast near a range of mountains is more likely to be an earthquake region than any portion of a great plain; though of course small slips may occur anywhere, with less frequency.

Still more extraordinary consequences have been suggested of late as probably resulting from this flotation theory, which is associated with the name of Professor Wegener, and is called sometimes the Wegener hypothesis. Some of its recent developments are due to Professor John Joly, F. R. S., of Dublin. The moon is known to have been broken or squeezed off from the earth in long past prehistoric ages; and the scar left by its separation is now the mere residuum of a depression called the Pacific Ocean.

There was no liquid water or reasonable atmosphere in those very early days; and the earth had no semblance then of what it is now. It was long before the formations which are studied in geology. It must have occurred thousands of millions of years ago. But long after it happened this scar would be deep, and all the water would accumulate there, when water could make its appearance. The great bulge of land would be in the opposite hemisphere, high and dry. But this state of things would not last forever. There would be a tendency for solid matter to fall and move, so as to fill up the cavity. Moreover, a great floating mass of land might break up, and a part of it drift away from the rest. The shape of America looks as if it had once fitted on to Africa and Europe; the idea is that it once formed part of that great continent.

But there are certain propelling forces, partly due to the rotation of the earth—which could be explained more at length—that tend to push a detached mass of land, cracked or separated from the rest by some great convulsion, tend to push it towards the west, in a direction opposite to the rotation of the earth. And thus the floating mass, floating in the viscous magma above spoken of, would in the course of ages gradually travel, so that water flowed into the interstices or intervening space and became what we now know as the



The photograph taken inside the Kilauea fire pit, showing the flow of lava through a hole in the wall, which Prof. Jaggars got at great risk of his life, after being lowered inside the pit and uncomfortably close to the 2000-degree mass of molten lava. This photograph is, of course, a time exposure

—the stuff of which the Giant's Causeway, near Portrush in the north of Ireland, is made. This rock becomes plastic and viscous, like sealing-wax or pitch, at a reasonably high temperature, long before it melts. It contracts on solidifying—that is the reason of the hexagonal clefts in the Giant's Causeway; and, hence, pressure would keep it solid, and prevent its melting. It is not, therefore, molten in the ordinary sense, even in the hot depths of the earth. It would not yield to tidal forces, which last only for a time measured in hours; but it would yield to forces which continue uniformly to act over centuries or thousands of years.

The modern view, then, of the crust of the earth is that at a certain considerable depth there is a vast accumulation of this semi-plastic material, solid and unyielding for all ordinary purposes, but yielding slowly like a fluid to very long continued forces. In this magma the continents are believed to be floating—floating as it were like icebergs in a sea of pitch—solid and stable enough to all appearance, and yet liable to slow and regular movements, of a kind which would be experienced quickly by any ordinary floating body. Some parts might rise, opposite parts might sink; and this sort of slow disturbance is known to be going on. Even in England some parts of the coast are rising, so that the sea is retreating; in other parts

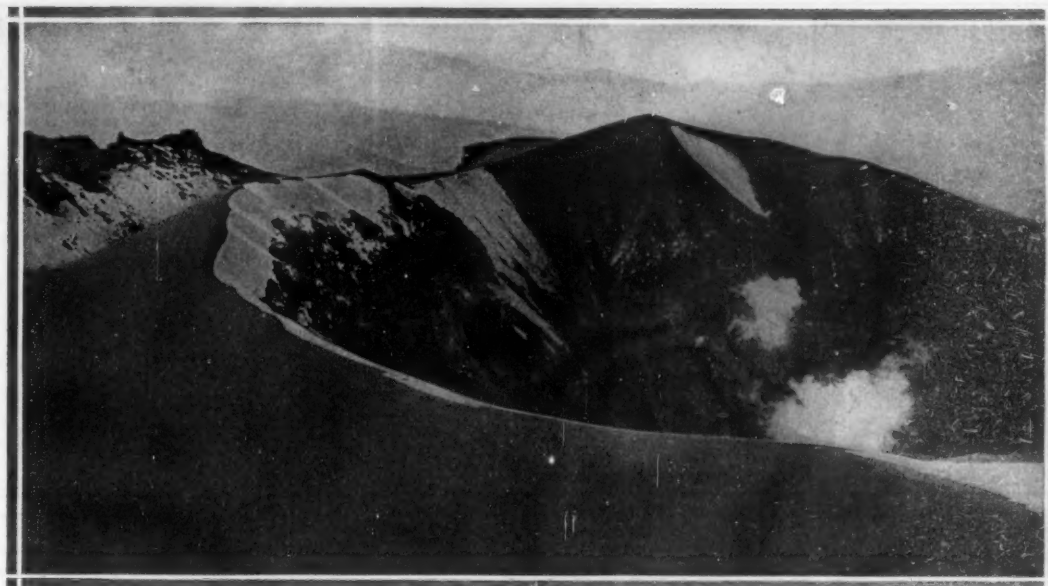
Atlantic Ocean. The pushed continent would tend to crumple up on its advancing side, and would thus form the Rocky Mountains and the Andes, which at one time may have been much higher than they are now; ordinary atmospheric processes of degradation and denudation would wear them down, and a coast line would be formed even on their advancing side; and there would be any number of minor upheavals and sinkings, in themselves fairly slow, but not slow in comparison with the majestic movement of a whole continent.

On the opposite or eastern side of the earth there would not be the same pushing force tending to separation; but there would be a precipitous descent into the cavity; that is, the lands there would be standing on the edge of a precipice. This would inevitably lead to a certain amount of separation; and still more would it lead to occasional cataclysmic disturbances, or breakage and falling in of some portion of the crust.

Anyone living on a mountain side or the edge of a precipice must know that it is rather a dangerous position, and that a landslide may occasionally occur. Japan is situated on just such a precipice. The land slopes down sharply into the depths of the Pacific Ocean, the gradient there being much steeper than on the west coast of America; and accordingly it must be peculiarly liable to the sudden collapses that we call earthquakes. The Philippine Islands are on the edge of another deep chasm.

Now if a breakage of the crust occurs at any place, it is bound to be accompanied by a violent shaking; and this shake or earthquake tremor travels through the rocks at a great pace, giving them a rapid horizontal vibration. The vibration may not be much in extent; it may be only an inch or two. But if the foundations of a house are shaken by a couple of inches by such enormous forces as can shake it rapidly, the brick and stone of the house cannot follow the movement, and the whole structure is liable to collapse. The design of houses in ordinary countries is not adapted to this rapid shaking of the foundations, and damage is bound to result. Even a small tremor, much less than an inch, will do serious damage.

When a breakage of the crust occurs under the sea and a cleft is formed, it is quite possible for some water to get into the cleft and descend to regions of high temperature, where it will be converted into steam, and may cause something more like a volcanic explosion. There appears no need, however, to call in the aid of steam in order to account for the damage done by a fracture in the earth's crust near an inhabited country. Moreover, the shock of the disturbance travels far and wide as an earthquake wave. It travels through the deep-seated rock at a greater pace than through the surface crust; and hence a distant station—it may be a thousand miles away—usually experiences a double shock or double series of vibrations, one set coming through the deep earth itself, another coming through the surface crust a little afterwards. The speed with which these two waves travel is approximately known; and hence, by the interval between them, an estimate can be formed of the distance at



The crater of El Misti, 19,260 feet high in the Andes

which the original catastrophe must have occurred.

If two people go to opposite ends of a long iron railing, and one of them hits the rail, the other can adjust himself so as to hear two knocks, one coming through the iron, the other through the air; the speed of sound in iron being four times that through air; and by timing these sounds he could reckon how far away the person was who delivered the blow, even if he did not know. If he were listening in the middle of a long railing running east and west, he might be uncertain whether the sound came from the east or from the west; to tell that, he would have to compare notes with other observers. But if there were two listeners with a little distance between them then either of them could tell the distance, and both of them together could tell the direction; for the nearer one would receive the wave before the other.

To imitate the condition of an earthquake observer, we might imagine railings running north, south, east, and west. Then suppose two observers, both on the east and west line, get the shock simultaneously—they would know that it must be coming from the north or the south; whereas, if one received the sound before the other, say the more easterly one, they would know that it was coming partly from the east. But to localize it with any precision, more than two observers would be necessary. They must have instruments which would record the accurate time of the shock, and they must telegraph the results to each other. Roughly speaking, that is how it is done. It is somewhat akin to the sound-ranging by which guns were localized dur-

ing the war, by timing the arrival of the sound at different stations.

The earthquake wave is not a sound in the ordinary sense, though it travels with the speed of sound in the different materials through which it comes. It is a quiver which has to be registered by ingeniously devised pendulum instruments, some of which we owe to the great earthquake observer, the late John Milne, who spent many years in Japan; and some of which we owe to Sir Alfred Ewing, now Principal of the University of Edinburgh. Many observing stations, equipped with these delicate and ingenious instruments, are distributed in nearly all civilized countries.

The above is a cold-blooded account, or summary, of the immense amount of knowledge that has now been acquired about the crust of the earth in the past and present; and the wonder is that the earth is as stable and habitable as it is. But it is not really stable; and we are wakened up to the fact of insecurity every now and then by one of these cataclysms which, though small and insignificant from the cosmic point of view, have a terrible effect upon humanity. Man is a mere pigmy among these convulsions of nature; he is a child of nature, a child of the earth, as we might say, and must suffer for the storm and immaturity of his parent. It is all good and wholesome for us in the long run, however dreadful it seems at the time; and at any rate we may be thankful that the distress and loss of life has not this time been brought about by human wickedness. Man is not responsible. And under those circumstances, though we are horrified, we need not be unduly distressed or depressed. A world-wide calamity that destroys whole families is, I expect, less heart-rending than one which picks out here one and there another. An earthquake destroys indiscriminately; it does not select the young and vigorous for destruction; indeed, they are more likely than others to escape. In nature there is a survival of the fittest; in war there is a destruction of the fittest. The longing to help, and the sympathy which is called out by an earthquake cataclysm, are all to the good. These occurrences are part of the mystery of life and death. We are not responsible for them; we must do what we can to help, and retain our trust in the wisdom and beneficence of Higher Powers.

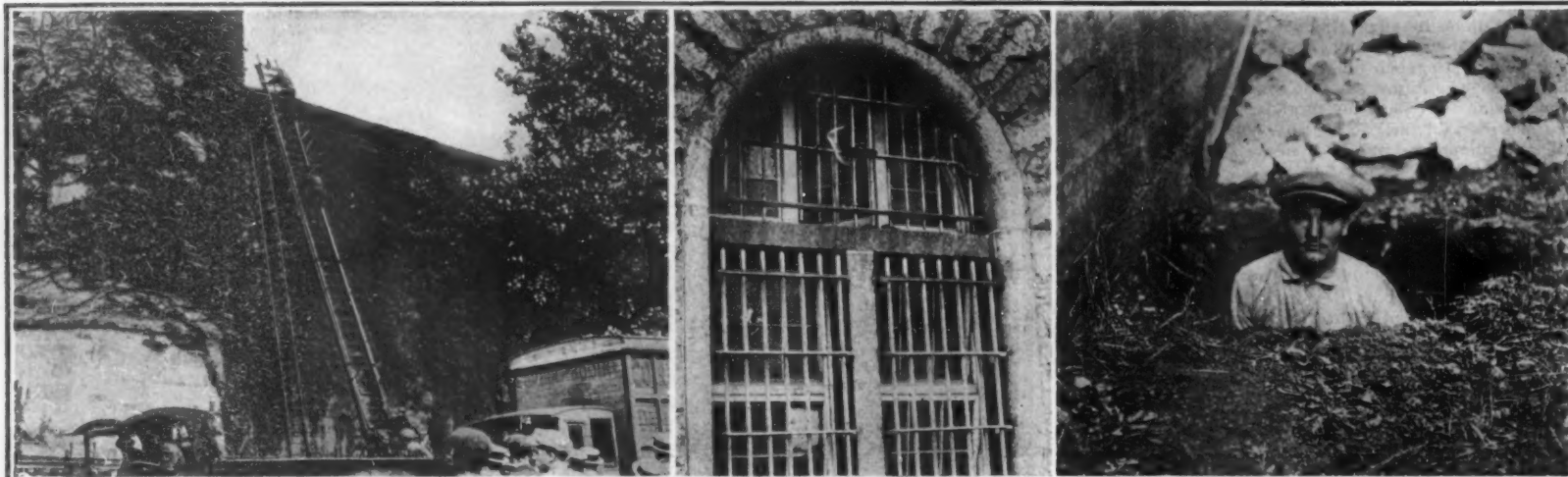
Photographs of the Inner Body

ACCORDING to the report of the Paris representative of the American Medical Association, Drs. A. Kotzareff and L. Weyl, by the use of radium emanation added to blood serum, have been able to obtain photographs of cancers inside the body. The new method involves withdrawing from the body a certain amount of blood. From this blood the serum is obtained. To this blood-serum, a definite dosage of radium emanation is added. The radium treated blood-serum is then injected into the body. The radium emanations tend to locate in the most rapidly growing tissues, such as tumors of a malignant character like cancer. When a photograph of the body is made, the presence of the radium emanation manifests itself on the photographic plate.

When this method was applied to a pregnant guinea pig, it was found that after a certain period of time the radium emanations concentrated in the embryo.



Group of five live craters in Java, Smerve at the top and Bromo below being active at the moment, while the other three are temporarily quiescent



Left: Fire ladders, etc., being used to study the point of departure of a group of escaped criminals and, incidentally, to demonstrate the height of the wall which they had scaled with home-made rope ladders. Center: The irregularity in the pickets at the top of this picture is not very conspicuous; but, made with an improvised crowbar, it was sufficient for the escape of two men. Right: The outer terminus of the tunnel that carried several industrious residents of Atlanta into a more congenial atmosphere

Interesting escapes that have involved inventive ability on the part of those who engineered them

The Criminal as an Inventor

Some Curious Contrivances of the Oblique Mind that Have No Prototype in Legitimate Technology

By Edward H. Smith

ABOUT the year 550 the Emperor Justinian turned smuggler. Somewhat earlier, when the prodigal Theodora was still alive and alight, he had allowed himself to become enmeshed in silk. Whether, as our romantics will have it, this was merely another lovely indulgence to gratify the roving opulence of his gutter-born imperatrix, or an astute bit of statecraft aimed at a Persian monopoly, we cannot determine at this pathetic distance. In either event, the most celebrated member of the Byzantine line did become interested in sericulture and, by that token, a common criminal.

Silk had been reaching Europe since before the Christian era, from China, in the caravans of the traders of Iran. The first came to Greece from Cos in the shape of a tissue so fine that "it revealed rather than clothed the form." Later the raw product began to reach Rome, where it was more valuable than its weight in gold. Always it had been carried west by the Persian merchants, who were said to have gleaned enormous profits from the traffic.

But nothing came to Europe except the fiber or the woven tissues of the east, and silk remained a mysterious, even a fabulous stuff, wherein shone the moonlight of great deserts and the spilt blood of swart alien men. So for most a thousand years.

Then two Perso-Christian priests reached Constantinople and the attention of Justinian. They had been proselyting in China and now carried back with them something that must have been regarded as more precious than converts—the secrets of silk culture. Justinian was told what Aristotle had vaguely guessed at. Immediately his imagination glowed. He commanded the missionaries to return to China and bring him back some of the eggs of this wondrous worm.

But how could that be done? the priests protested. To take the silkworm or its egg out of China was an offense for which generals and princesses had paid toll to the headman.

Justinian pointed to the bamboo staffs his informants carried. Were they not hollow? Could not the eggs of the *bombyx* be concealed therein? So the Christian missionaries went forth, stole the eggs of the forbidden silkworm, smuggled them across Western Asia as the emperor had suggested and so brought the rearing of the most valuable of fabrics to Europe.

The story of the imperial master of Byzantium and Rome cannot pose either as a rare example of crowned criminality nor as the first case of inventive talent applied to crime, but it serves well enough to introduce the subject of the artfulness and inventiveness of the criminal in every time and age. Smugglers have surely not been the least ingenious of men in this direction, and Justinian's improvisation of the bamboo egg-carriers can hardly be rated high among the inventions of this crew. When one considers how gems have been smuggled out of Golconda and South Africa by nude

natives, how such bulky products as salt, tobacco and tea have been constantly dealt in where the governments held a monopoly or enforced a heavy impost, with what generality of success diamonds are brought into this country from abroad, the handling of a few insect eggs becomes insignificant. One thinks of the false bottomed trunks, the hollow heels and walking sticks, the concealed seams and pockets in women's clothing—all the thousand and one artifices that come to the attention of our customs men every year. One must recall, also, the enormous business of liquor smuggling that is today one of the most remarkable political and social problems, and consider the thousand artifices and special devices employed therein. Drug smuggling is, however, the most interesting and baffling field of this crime now in existence and to it most of the ingenuity of the modern smuggler is devoted. To attempt a recount of all the curious devices used in the traffic would be to reprint the newspaper accounts and the photographs of the illustrated supplements covering the last half dozen years. Everything from a false top in a hoghead down to a false back in a woman's watch has been tried.

In earlier articles of this series, which designed primarily to show how the fight is waged between the criminal and the inventor, it has been made clear enough that the lawbreaker has inspired many of the devices and mechanisms that are the familiar safe-

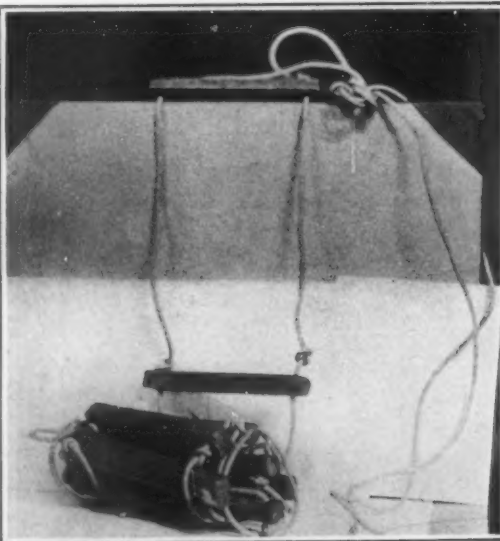
guards of modern life. Incidentally, many contraptions of the criminals themselves have been dealt with, such as the various mechanisms and cheats used by gamblers, the fire bombs of commercial incendiaries, the various tools and implements of the check forger, the methods of the instrument forger and his enemy, the handwriting expert, the special equipment of automobile thieves and the like.

A great many of these have not been created by criminals at all but devised for legitimate use and then converted to misuse. Many devices employed by gamblers were made up for the innocent performances of parlor magicians. The tools of the forger and counterfeiter of paper currency are those of the engraver, paper maker and accountant. Bank and safe burglars have adopted nitroglycerine and the acetylene torch from industry. All this has been made clear. There still remains, however, a considerable body of mechanical and other creations, of which Justinian's hollow staff is an instance, and which belong to the "crook" himself.

The largest field belongs to the burglar. A complete statement of all his creations would involve a history of the art of breaking and entering, surely one of the oldest among men. One wonders immediately what tools the Egyptian grave robbers used who broke into the pyramids some five thousand years ago and into the rock hewn crypts in the Valley of the Tombs of the Kings eighteen hundred years later. Probably nothing more formidable than bronze chisels and hammers and boundless patience, wherewith to work a way through enormous thicknesses of stone.

Nor may curiosity quite pass by the tools used by classic housebreakers against those crude strange locks that closed the houses of Greece and Rome against the wandering thief. Indeed, there is reward of information on this topic for the patient researcher in every civilization, however lost in time. To every tribe there has come property and with it the thief. To every hamlet, every half barbarous village, advancement has brought the permanent dwelling and with it the breaker in. Thus locks were ushered into the world and by their token burglars' tools.

The tools of the eighteenth and nineteenth century housebreaker seem most fascinating. There are reprinted herewith some photographs of these tools. It cannot be said that they differ greatly from the implements of other mechanics. They do, however, belong distinctly to the inventions of the criminals themselves. We see, for instance, a great assortment of skeleton keys, used to open the warded locks of the late nineteenth century and still effective against the simpler bolts of today. The tools of coiners, also, look like ordinary implements, but criminals used them first and devised them in this form. Most men are familiar with what the American underworld calls brass knucks and the British knuckle dusters. These, and their deadly relative, the skull dagger, are the inventions of



Rope ladder invented by a "second-story man," so made that it can be wrapped about the body and carried without detection

thugs and roughs, and have no honorable prototype.

There is also the photograph of the tools used by the famous Charles Peace, an English burglar of the 1870's, whom many British writers upon criminal subjects seem to regard as a most remarkable and masterly housebreaker. The tools are interesting because they show the home-made implements of fifty years ago for contrast with the finished devices and mechanisms used by burglars today. Perhaps the popularity of Peace as a notability rests on some such ground or, more likely, upon the facts that he owned and loved to play Cremona violins, that he was a giant fellow, an irrepressible amorist and in due time a victim of the gallows, for that he shot an interfering and contumacious husband.

The inventions of prowlers, as housebreakers are called in the argot, may not, however, be limited to such men and times. Before Peace's day, an American breaker had invented the dark lantern or bullseye, from which all the modern electric flashlights have been adapted. Wooden wedges, with which to attack the mortar in brick or stone walls without causing the ringing sound of a steel chisel; hammers capped with thick pads of rubber, to further deaden the sound of blows; the jimmy and its child, the collapsible jimmy; the fine steel wedges used in working a crack into the jamb of a bank safe to admit of the infiltration of nitroglycerine; the finespun ropes of silk by which burglars let themselves down from the roofs of the tall loft and apartment buildings in New York to gain entrance through a window two hundred feet from the ground and a hundred or more from the roof; all these and many more belong to the burglar's inventive domain.

Far more romantic, however, than these instruments used for breaking in are the inventions employed for breaking out. The strange contrivances which imprisoned men have bent to the great purpose of freedom must form a thick chapter in any volume presuming to contain even the first color of the romance of escape. We need not concern ourselves here with the file that Casanova had smuggled to him in a great pie, with the familiar saws and cut bars, with the ladders of torn bedding by which men have scaled walls against freedom. No vitality shines from such commonplaces.

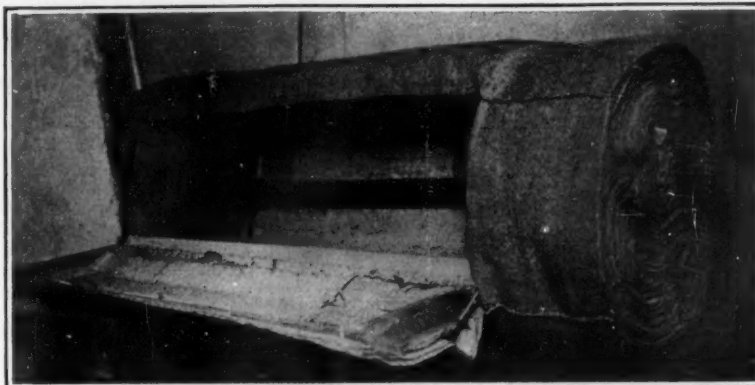
But where these familiar things leave off the strangeness begins. Incarcerated men have picked up bits of wire in the yards, shops or stables of prisons and fashioned from them picklocks by which scores have been liberated. A bit of rusty tin has been taken and by prodigies of labor and patience wrought into a tool to set at naught all the precautions of warders and prison architects. In 1846, Louis Napoleon, a prisoner in the fortress of Ham for his opera bouffé invasion of France a few years earlier, let his aides, who were permitted to live in prison with him, get the prince up in the clothes of a workman. So attired, he took a long wide plank on his shoulder, stuck his riding boots into big sabots and marched out of prison without a word, the turnkeys accepting him as a carpenter without question. Six years later the same escaped convict was emperor of the French.

This exploit was emulated a good many years later at Dannemora by no less an offender than the celebrated Soap-box Hardy, who quickly slipped on the uniform of a painter, which had been left hanging in the clothes room. Picking up a brush and pot, he, too, walked blithely out into the sunshine and golden air of freedom.

A few years ago in one of our western State penitentiaries a convict escaped by the old manner of cutting through his bars. He was at liberty only a few weeks or months when the police picked him up and returned him to his shadowed house. The prison officials, as is common in such cases, demanded to know where the man had got his saw. He shook his head with dejected doggedness and said he'd used none. Guffaws among the warders. Still the man blinked, held himself in a kind of stupor and insisted that he had not used a saw, that no one had smuggled such an instrument to him and that he had been without accomplices. The keepers menaced him and applied their tongue starters. Their victim bore the pain as best a man

can in silence. They tossed him into the dungeon, where he lay groaning but spoke no word.

Eventually, the many won another of those struggles which the ego seems destined to lose. The escaper gave sign that he was willing to talk. They dragged him from his hole and he shuffled away to the machine shop, where he looked about and finally picked up a bit of twine. This he dipped into the gluepot at the far end of the building, where the carpentry was done. He carried it dripping back to a steel table where some



Outside, an innocent roll of cloth. Inside—the smuggler's delight!

emery was lying about and twisted his sticky string in the powder. As it dried the bits of emery held fast and he had a moderately effective contrivance for an immoderately patient and determined man. He said it had taken him three months to cut through the bars in this fashion. The officials believed him and so set down the case upon their books.

They put this remarkable escaper into another cell and took precautions against the abstraction of twine and glue and emery powder. Nevertheless, at the end of about three and a half years, the same man again made his escape and his bars showed that they had been cut through in exactly the same manner as before.

The prison intelligences began to waken at this. The man had not had access to glue or emery or twine this time. As a matter of fact, he had before the previous escape been employed in a quarter of the prison which must have made it impossible for him to visit the shops and get string after string of glued emery. The convict had hoaxed them.

This time they did not get the bar cutter back, but his story is well known among the underworld elite. The man had used nothing but woolen strings carefully drawn from the rough stockings furnished by the State. These he had moistened in his own spittle and then rolled in the dust of his floor, sticking them

the bar, then listening intently for the rubber shod footfall of the roundsman, then swiping again at the cage, till the night was half spent. He got little sleep. They worked him hard in the brickyard. He lost weight and grew ill. Still he did not give up. He suspended his work for a time, till strength returned. At last he had one of the two necessary bars cut almost through, so that a quick wrench would jerk it from its place. He smeared the cut with earth and lime and touches of green paint and red brick dust. And so he

attacked the second.

The prison officials did not suspect him. They made cursory examinations of his cell but did not sound the bars. Besides this man was an emery user and he had none!

Slowly again then, like the drop of water on the slab of granite, like frost and thaw at the heart of a crag, like time itself against the mountains of the world, this insuperable man went on to cut the single bar that stood against his freedom—a thing most likely empty, a mere word. It took him almost all of three and one-half years to do this deed of forfeit valor and sublime

tenacity. Once ready, he rested and ate his fill again, so that his strength might not fail him, once his foot was on open ground. Then, one night when the moon was beyond the world rim and clouds had soiled the faces of the Pleiades, he was gone.

At the Federal prison at Leavenworth, in 1901, the invention of a convict made possible the historic mutiny and jail break in which twenty-seven determined men got away, after killing and wounding their keepers.

The new prison, as it was then called, was being built by convict labor, on a hill site west of the town. The convicts were kept in the old prison, later called the military prison, in the fort, two or three miles away. Every morning a file of four or five hundred convicts was marched out of the old prison and along the roads and stream beds to the new side. Here they worked inside a wooden stockade, laying bricks, erecting walls, building the very cells that were to contain them in the future.

One sunny afternoon three or four of the leaders among the convicts walked over to a point of the stockade, stuck their shovels into the earth, turned over a little sod and procured several heavy revolvers and extra ammunition, which had certainly been planted there by accessories from the outside. So armed, they advanced on the main gate, which had a tower above it, occupied by a guard with a repeating rifle. Inside guards rushed to head the mutineers off and were shot down or driven to cover. In an exchange of shots between the convicts and the tower guard one convict and the guard were killed. The gates were thrown open and the convicts ran out, followed by others to the total of twenty-seven.

The puzzle of the thing was solved when one of the ringleaders fell into the hands of the prison authorities and confessed. This man had been in communication with an outside agent by means of secret writing. The prison people were more puzzled than ever. What means of secret writing had men within the prison walls? How could they get the necessary tools and chemicals? What code had they that had passed the eye of the prison censor?

The captive leader drew a piece of calendered paper toward him and asked for ink and a pen with two clean points. With ink on the first point he scrawled out a conventional and innocent letter of the very kind a convict would write home. The officials did not even note that the lines were spread rather far apart.

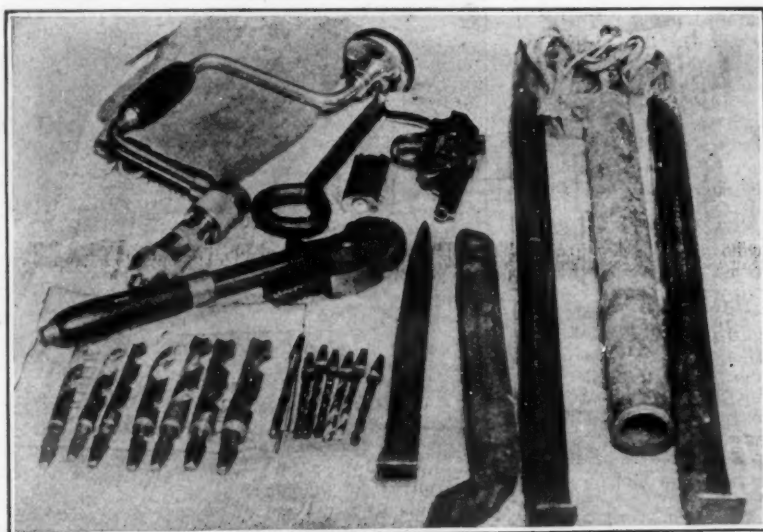
After this writing had been permitted to dry thoroughly, the demonstrator put the clean pen point into the holder and moistened it with his tongue. Thus, with spittle, he wrote between the lines of the original letter this menacing sentence:

"Leave four gats and extra shots buried inside and under thirty-fifth paling of stockade west of main gate by October 5."

There were no magician pen-top readers present and none knew what had been set down.

The captive allowed the sheet to dry completely. Then he passed it among the officials, asking if any could see any marks or make out any letter. All were baffled. Laughing shortly, the convict dipped a small sponge into the inkwell and rapidly spread the blue ink

(Continued on page 426)



The typical kit of tools of the up-to-date burglar. While in a way modelled after ordinary tools, they are of decidedly specialized form

against the stones of his cell wall till they had partly dried. With these frail strands he had attacked the inch-thick steel bars.

At night, when he had been locked in his cell and the lights-out signal given, this giant of patience had crept from his couch and begun pulling his sandy string back and forth across a bar. It took many nights before he made an impression, taking a few swipes at

Taking the Stenches Out of Industry

The Embarrassments of Left-Handed Perfumery, and How They Are Often Eliminated

By James H. Collins

ONE little item in Bingville's daily house-keeping—three thousand tons of garbage, more or less.

Day after day the city hauls it away and dumps it. Soup bones and potato peelings, melon rinds and apple cores, the burnt hash from the boarding house and the poor little

bride's first biscuits, mixed with such-and-such a percentage of tin cans, empty bottles, broken glass and china and lost silver—it doesn't look much like wealth! But there are dollars in it—4 per cent of recoverable grease worth easily three million dollars yearly and 11 per cent of tankage for fertilizer, worth a million or two more. Call it a round five million, or a good home built every day for some taxpayer.

Some years before the Great War began a corporation made a contract with Bingville to take this garbage and render out the grease and fertilizer by an odorless process, keeping those by-products for its trouble and relieving the city of expensive hauling and dumping. Construction work was begun on a large plant, but before it could be put into operation the war upset things. Steel trebled in price, coal rose from \$3 to \$8 a ton, wages for common labor from \$1.75 to \$4.50 a day. So the rendering plant cost more than its promoters had estimated. That didn't trouble them when they first got going, because grease and tankage were also selling at better prices. But it was soon found that operating costs were higher, too. And then, when we got into the war, those food conservation signs "Save the Fat!" cut the amount of grease in Bingville's garbage to such an extent that, where there had been eighty pounds to the ton in normal times, thirty pounds was about all that could be hoped for.

That rendering plant had to shut down, and today stands idle, while Bingville has gone back to dumping its garbage. Unbalanced business conditions during the war were to blame for this failure, but it was actually a bad smell that caused the shutdown. They built their plant believing that, with modern engineering practice, garbage could be unloaded and treated without offensive odors. But several hundred thousand dollars were spent unsuccessfully in efforts to make the process inoffensive.

Chemists and engineers worked on the problem, and the solution often seemed to be just around the corner. Inventors turned up by the score, announcing that they had solved it, and offering to install an apparatus that would make the place as sweet as a cow's breath—not altogether the free-lance inventor with a wild look in his eye, either, but bachelors and doctors of science in the employ of responsible corporations. Generally, they wanted about five thousand dollars to install their apparatus, seldom any more, and in many cases only two or three thousand. But when the garbage company made a counter proposal, offering to pay twenty-five thousand if the apparatus eliminated odors after the inventor had installed it at his own expense—it had no takers!

By the rendering process used in this plant, the garbage was brought in as quickly as possible, to have it fresh and least odorous. After cooking to extract the grease, the residue left was dried down into "tankage" valuable to the farmer for its nitrogen and humus. Practically all the odors went up a very high chimney in the form of heated gas, except the odors of cooking, which were kept pretty well inside the plant. In these gases, something like thirty to fifty tons of fine dust went up the chimney every day. This dust had a bad odor. Believing that it carried all the odors, engineers installed apparatus to wash it out of the gases with

sprays of water. In this way, practically all the dust was extracted. It had a vile odor, and though rich in fertilizer values for the farmer, was so difficult to dry that the company let it run into the sewer.

But the gas going up the stack still smelled!

Then they tackled the moisture in those chimney gases. You have probably noticed that the fragrance

of flowers in the country, and new-mown hay, and freshly turned earth, is sweetest early in the morning when the grass is heavy with dew. Water vapor in the air carries this fragrance—and tons of water vapor going up the stack carried some of the fragrance of garbage, in quite the same way.

So apparatus was installed to condense this moisture by blowing the chimney gases through water sprays, and all but a very small percentage of uncondensable gases were eliminated from the chimney.

But the small volume of those uncondensable gases had positively the worst odor of all! In the laboratory, they could be made odorless by very high degrees of heat, but it was never found possible to apply this principle commercially, as the cost of extra coal would have been prohibitive.

Despite these efforts, the plant had a bad reputation among people who lived around it. Certainly, a large proportion of offensive material in its chimney gases were kept out of the atmosphere, so it was not actually as bad as a garbage plant run without such deodorizing devices. But people complained of bad smells, nevertheless, and in the end the health authorities closed it as a nuisance.

The final chapter was interesting:

The health authorities insisted that the plant gave off bad odors, and the management, while admitting that some odors escaped, maintained that they were not in sufficient volume to be offensive. The chimney was high, and shot its gases out at such an altitude that odors did not reach people living nearby, but were generally reported at such distances that the garbage works had a pretty good alibi. However, when the health authorities sent up an airplane with two men who cruised down the wind until they smelled garbage, followed it straight upwind, and came to the garbage company's chimney—the jig was up!

Millions of dollars have been lost in the search for a denatured garbage-rendering process, and some of the engineers who have gone furthest into this proposition declared that the wealth in garbage is like the gold at the rainbow's end.

"I have solved the puzzle over and over!" says C. R. Van Etten, an engineer well known as a specialist in this field. "Once I knew all about it, but now there is only one thing I feel sure of—that incineration is the

best thing for garbage. Burn it up! Reduce it to the irreducible!

"That is, incineration by methods such as they have developed over in England. An incinerator of the latest British design might be operated alongside a cathedral, so far as offensive odors coming from garbage after it enters the plant is concerned. Garbage is generally self burning, for besides table scraps containing fat, it is mixed with paper, wood, leather, cloth and other combustible rubbish. These incinerators burn it at very high temperatures, 1400 to 2000 Fahrenheit, destroying practically everything. Instead of one furnace, a series is used, all having a common combustion chamber for mutual assistance. One furnace contains a fresh load of garbage, just started and giving off flue gas at a moderate temperature which would be odorous if it reached the atmosphere. An adjoining furnace, however, is in full blast, giving off high-temperature gases, and a third will be a mass of cinders, emitting even hotter gases. These gases are mixed together in the common combustion chamber, so that all odors are burned up and destroyed by the high temperatures before the gases escape from the chimney. Moreover, these gases are used to heat the forced draft that is drawn back through blowers to feed the furnaces. Incineration does away with much of the expense of hauling and dumping garbage. It can be collected and burned at small incinerators scattered over the city. Indeed, incineration has now begun in our cities, for practically every large apartment, hotel and institution built nowadays has an incinerator installed as part of its equipment.

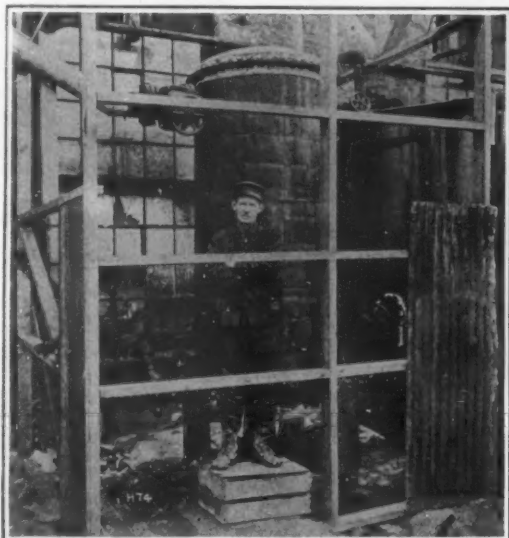
"On the surface, the wealth in garbage seems like easy money. But try to get it out at a profit, and you will find that it is the squeal of a pig not worth saving."

But right in those war times that were heaping trouble on the Bingville garbage works, there stood at every other city street corner a barrel which, had the garbage men only known it, held something new and promising in the way of odorless reduction. You remember those barrels—common flour and sugar barrels, beautified with white paper and a Red Cross sign, into which people threw coconut shells, peach stones and other fruit pits to make a peculiar kind of charcoal that the Army wanted for gas masks.

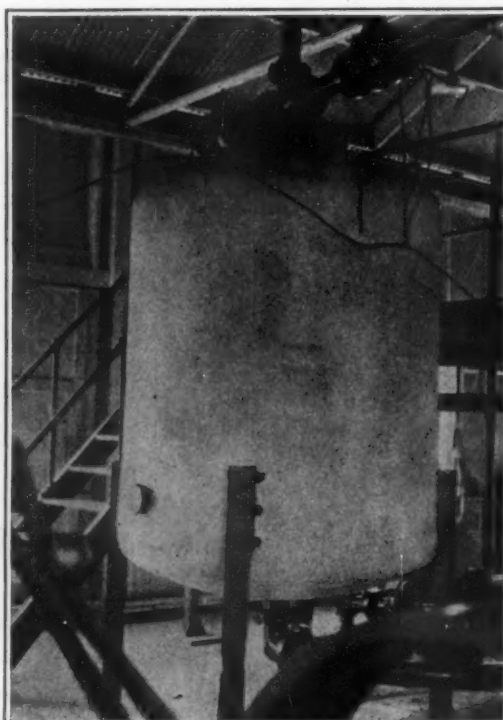
Out of those barrels the chemist eventually evolved "activated carbon," a substance that promises to free industry of all offensive odors, bringing the packing house, glue works, soap factory, fertilizer plant and like establishments, now often banished to the waste places, right into town where they will be handy to raw materials, transportation facilities and customers. Better yet, it may squeeze money out of a noisome industrial smell, yielding by-products to pay for the trouble.

The chemist and inventor now seem to be closing in on the offensive odors of industry from several directions, after many failures. They have tried to wash out bad smells, to burn them out, to concentrate them, to shoot them so high up tall chimneys into the welkin that they would vanish—even to make people like an objectionable stench by perfuming it with some volatile, pleasant-smelling chemical.

Some of these methods were successful in making the factory itself odorless. When the visitor goes through a certain big eastern soup-canning establishment, for instance, his attention is called to the fact that there is practically no odor of cooking. The



Activated-carbon absorber used in removing odors from the air



Activated-carbon absorber by means of which gasoline is recovered from natural gas

bouquet of good warm nourishing soup is pleasant, of course, but they keep it out of that factory with large rotary blowers. If you want to smell the soup, it is necessary to go several blocks away from the factory.

However, even the most offensive industrial odor doesn't bother people working in the factory that creates it. They become accustomed to it in a few days and smell nothing. It is the same with pleasant odors—the young lady with a job in a perfume laboratory is fragrant as the rose, the lilac and new-mown hay. People know when she is coming a block off, but she herself smells nothing. And offensive industrial odors are seldom harmful, unless they contain actual poisons, like acid and ammonia fumes. Bad smells may nauseate people unaccustomed to them, but workers in the odoriferous industries are generally pretty healthy.

It now seems quite likely that, within a few years, when people complain of an offensive factory, its odor can be scientifically eliminated by one of several methods lately discovered. They have been carried through the laboratory and experimental stages, but not yet widely applied on a commercial scale because there is still considerable research work to be done on the particular perfumes of the different industries.

The smelter fume nuisance has been largely done away with by Dr. Frederick G. Cottrell's famous precipitation apparatus. Before this invention, crops and vegetation for miles around a copper smelter were often killed by the fumes from its stack, causing constant complaints and disputes. Farmers maintained that the fumes were "pizen," while smelter men insisted that neighboring agriculturists were really "smoke farming"—that is, planting crops near a smelter, not with any idea of marketing them in the regular way, but to collect damages from the smelting company if they didn't thrive. The Cottrell process doesn't really affect smelter fumes, but simply precipitates metal and dust particles from them with electric currents of very high frequency. Besides saving valuable metal dust, it allows the gas, fumes and smoke to pass up the stack hot, where before the dust was washed out. This cooled the gases so that they sank down on the surrounding neighborhood and made trouble, whereas hot gases rise and are diluted with air, doing no harm. The apparatus is also used in cement kilns to prevent damage to surrounding vegetation by cement dust. Dr. Cottrell's invention has also been of great public service because all the royalties that it yields go to finance scientific research, his gift to the public.

The idea of soaking up a bad smell with "activated carbon," as you mop up dirty water with a sponge, grew out of the war-time chemical investigations of Dr. N. K. Chaney which made our gas mask far better than any used by either the Allies or the Germans. Your fruit pits

and nut shells were turned into charcoal. Charcoal is carbon, and according to the stuff it is made of—peach stones, coconut shell, wood or coal of various kinds—and also the way in which it is made, has more or less affinity for odors. Odors, good and bad, are carried by complex molecules taken up by charcoal, while the simple molecules composing air, water and some of the gases pass through unaffected. Some charcoals, like those made out of the leavings in the

gas-mask researches, Dr. Chaney had an all-around experience with offensive odors, fumes and gases, and learned that, with a charcoal gas mask, one could work in the foulest and densest odors and be wholly unaware of them. This little factory was investigated, all apparatus from which bad smells arose made airtight, the offensive gases drawn away in pipes and passed through activated carbon. The apparatus was built hurriedly, in an emergency, but worked so well that, though it was

installed more than a year ago, the factory has since run steadily without a single complaint. It took two tons of coconut shells to make half a ton of coconut shell charcoal for the carbon tower that acts as an odor sponge. The carbon is worth up to 75 cents a pound, and there was a moderate investment in kettle covers, piping, and blower equipment. The system is virtually automatic. The actual weight of an offensive smell is very small, so a carbon sponge of this type will operate a week before it needs squeezing out. Then the night fireman turns live steam through the system, distilling all the offensive material in concentrated form into the fire-box of the boiler, where the heat destroys the smells. When the carbon has been revived in this way, it is again a clean, thirsty sponge, ready for work. Such deodorizing charcoal has been used three years in some cases without deterioration—rather,

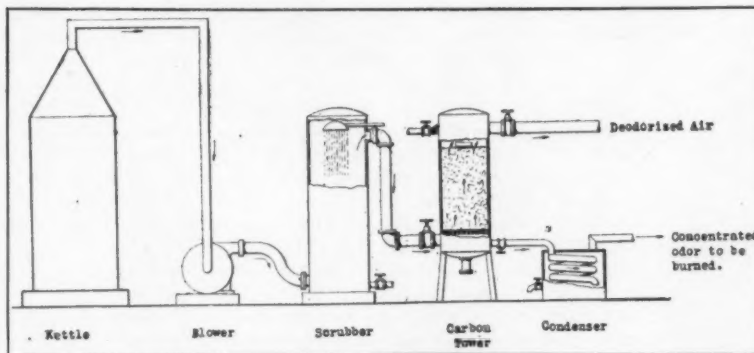
it seems to improve with use, and one shortcoming of activated carbon as merchandise is, that customers buy it so infrequently and for some purposes only once.

It may be that there is something worth saving in the odor from your factory. Or gases not offensive at all are dissipating good material as they pass out into the atmosphere. The waste gas created in fermenting corn, for example, contains acetone, butanol and ethanol, which can be caught by the carbon sponge and recovered by distillation. Gasoline, alcohol, benzol, ether and other volatile liquids used as solvents in many industries, and largely lost through evaporation, are now recovered by treating them as though they were offensive smells. Gasoline is also extracted from natural gas, thus far one of the principal industrial uses of activated carbon, and light oils as well as sulfur extracted from illuminating gas before it is sent through the mains to the consumer.

The principle is sound, but still so new that the practice for different industries must still be worked out by engineers.

Take the case of a garbage reduction plant as an illustration, where there are several hundred million cubic feet of chimney gases daily to be deodorized. Before the engineer can design an apparatus for such purposes, the chemist must measure what he calls the "stench load" of garbage gases. In extracting gasoline from natural gas, he has figured its weight per cubic foot of gas, the pounds of gas

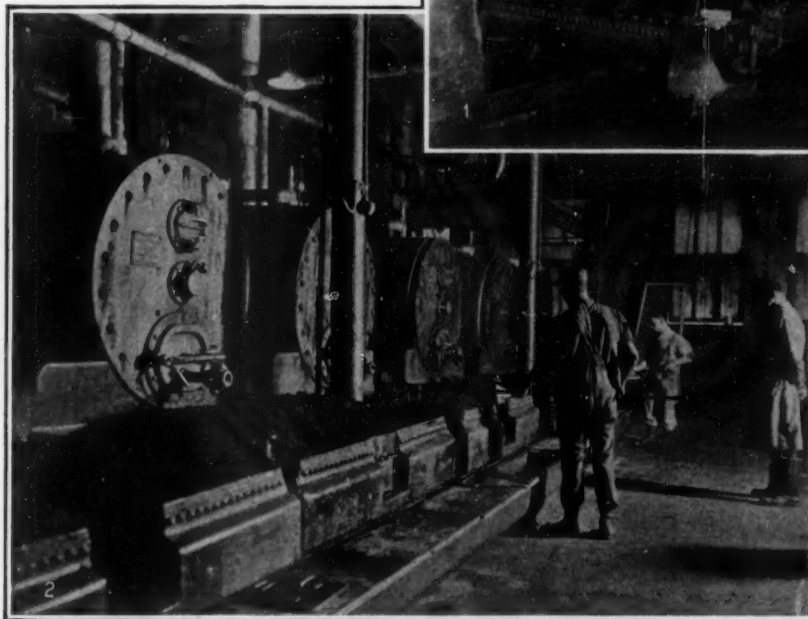
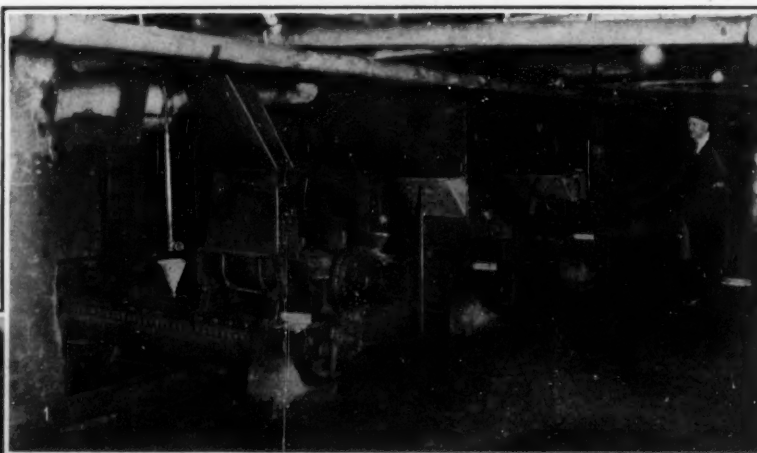
(Continued on page 426)



The general lay-out of an installation using activated carbon for the elimination of stenches

Red Cross barrels, are very active—sponges with such an insatiable thirst for complex odor molecules that they will take up more than 50 per cent of their weight of certain vapors, or one volume of charcoal will absorb fifty to one hundred volumes of odorous gas, depending upon its character. Other kinds of charcoal, however, have little affinity for odors. "Activated carbon" is a kind specially made to sop up and hang onto odors as they pass through a mass of it.

Suppose you have a factory so offensive that people are up in arms about it. Dr. Chaney and Dr. A. B. Ray have told, in one of their technical papers, the story of such a factory in an eastern State. It was a tiny place, employing only half a dozen men but—Oh, my! The owner honestly tried to wash and burn the odor out of his activities, but with no success, and finally was notified by the health authorities that he must either shut down or move away. During his



Above: Pressing tallow from cooked product. Below, left: Melting raw beef-fats. Below, right: Cracklings coming out of the press, ready for market
Taking the odor out of the packing industry by aid of a new process of dry rendering

Our Point of View

Charles Allen Munn

IT IS our mournful task to record the death of Mr. Charles Allen Munn, the late President of the Scientific American Publishing Company, in the 65th year of his age. His death occurred when our May issue was on the press, and in order to avoid the delay of one month in the announcement, we decided to publish an insert memorial which our subscribers received with the May number, but which was not available for our newsstand copies.

The subject of this memorial came of old American stock, the first ancestor of the family to settle in America being Benjamin Munn who served in the Pequot War. From him descended Reuben Munn, who raised a company and marched to Cambridge at the time of the Lexington alarm call, and who subsequently served under General Gates and was present at the surrender of General Burgoyne at Saratoga. The deceased was the second son of Orson Desaix Munn, who in conjunction with Alfred Ely Beach purchased, in 1846, a publication known as the SCIENTIFIC AMERICAN, which had been started in the previous year. It may truly be said that the history of the SCIENTIFIC AMERICAN during the seventy-eight years of its existence is the history of the life work of the father and son, for Mr. Charles Allen Munn, after preparation in Paris and in Princeton University, where he graduated in 1881, entered the office of Munn & Company in that year, and thereafter until the time of his death for a period of forty-three years, devoted himself closely to the interests of the SCIENTIFIC AMERICAN and its affiliated publications and enterprises.

Mr. Munn was at all times an enthusiastic sportsman; but, outside his business interests, the subject which lay nearest his heart was his collection of *Americana* and especially his *Washingtonia* which grew to be the most notable in the country. He was one of the leading authorities on *Americana*, and his town house at 62 East 65th Street, New York City, contained several of the best known portraits of Washington by Gilbert Stuart, Trumbull and Peale, the last named being a full-length portrait. The collection includes Wedgwood portrait cameos, mezzotints, miniatures, diaries, letters, etc., of Washington and others of the founders of the republic. Students and lovers of *Americana* will rejoice that this fine collection was willed by Mr. Munn to the Metropolitan Museum of Art of New York City.

Possessing an attractive personality, Mr. Munn gathered about him a large circle of friends among whom his loss is greatly deplored. Underneath his brisk business exterior, lay a very sympathetic heart, and it was rarely that any supplicants for financial aid who found their way to Mr. Munn's desk were turned away. His name was also to be found on a long list of philanthropic, church, social betterment, and kindred societies.

The deceased was a member of the New York Bar, and one of the charter members of the New York Patent Law Association. He was one of the founders of the Essex County Country Club, and captain of its polo team, and was a member also of the University, Century, Grolier, Merchants, Racquet and Tennis, Union and Knickerbocker Clubs. He succeeded as President by Mr. Orson D. Munn, grandson of the founder of the SCIENTIFIC AMERICAN, who will thus represent the third generation in the ownership of this publication.

Airplane-Battleship Controversy

IN OUR issue of December, 1923, we published an article credited to the staff and entitled "Driving the Bomber to High Altitudes," which gave some startling information as to the great advance which has recently been made in the range and accuracy of antiaircraft artillery. The facts were furnished by a high ranking officer of the Coast Artillery Corps, and were therefore fully authentic.

In our issue of April, 1924, we published an article "Bombing the Battleship," which was written by a

member of our air service, who requested that his name be not used as the author—a not infrequent request which is always scrupulously respected. Unfortunately, the editor who made out the list of contents for that issue was under the impression that it was a staff article and so named it. The nameless writer is evidently a strong partisan of the airplane side of the airplane-battleship controversy; but since we had already published Admiral Gleaves' article "Has Sea Power Passed?" in November, 1923, and the aircraft article in December of that year, both favorable to the defense against bombing, we decided to let this bombing enthusiast have his say and say it in his own hyperbolic way.

The immediate result of the publication of this last article has been the receipt of a letter of protest from Major-General Coe, Chief of Coast Artillery, and other artillery officers, who complain that the spirit, if not the facts, of the April article are at variance with those of the December article. The point is well made, and we repeat that the April article was not written by the staff but by a contributor.

The position taken by the SCIENTIFIC AMERICAN on this question of the supremacy of aircraft over ships of the sea has never varied. From the very first we have deprecated the extravagant claims of the air enthusiasts, and particularly of Sir (now Admiral) Percy Scott. The battleship never was, is not now, and for many years to come will not be in danger of being "swept from the seas." Scott's (or was it Fisher's?) "sack or scrap the lot" is picturesque and that is all.

And in our saying this, please do not suppose that we undervalue the great advance which has been made in naval and military aeronautics. For coast defense, for scouting, for spotting (after the enemies' planes have been shot down), and under exceptionally favorable conditions for torpedo-plane and bombing attack, the airplane has an undoubted value—limited today; capable of great development in the future. But until that development has proceeded to the point where the whole game can be lifted from the sea into the air, let us hold on to the well-proved system which we have.

The Great Flood at Panama

SOME twenty years ago when engineers were deciding whether to build a sea-level or lock canal at Panama, the controlling physical factor was the enormous floods which often descend upon the canal from the Chagres River during the rainy season. The opponents of a sea-level canal predicted that the enormous rush of water coming down the Chagres would produce currents in the canal which would render it unnavigable and threaten its very existence.

The advocates of the lock canal claimed that the only way to handle these floods was to build a huge dam at Gatun near the mouth of the river and form a lake over 160 miles in area which would catch and hold these flood waters and prevent their destructive effects. That the sea-level canal advocates were correct, was proved last October when the Isthmus was subjected to an unprecedented rainfall lasting a week, and there was a flood discharge into the canal that broke all previous records.

The dramatic details of this flood are described by Governor J. J. Morrow of the Canal Zone in an article in the *Military Engineer*, from which we learn that the probable inflow to Gatun Lake at the maximum period of the flood was between 250,000 and 300,000 cubic feet per second, and that for twenty-four hours on the 24th of October the Chagres discharged into the lake over 15,000,000,000 cubic feet of water.

Now Gatun had not only to receive this huge flood, but continually to get rid of it. It was for this purpose that the spillway at the center of the Gatun dam was provided with fourteen gates with a maximum discharge capacity of 200,000 cubic feet per second. Previous to this flood, the opening of seven gates had been sufficient; but as the downpour continued, two more gates had been opened, and then two more, making

eleven in all, and under these conditions a flood of 155,430 cubic feet per second was passing through this spillway. During the whole period, of the flood from October 22d to October 27th, inclusive, 42.4 million cubic feet of water were wasted over the spillway. This is equal to ten feet depth of water over the whole 166 square miles of the lake.

Except for some slides and wash-outs on the Panama Railroad, and a large slide into the Canal which did not seriously interrupt traffic, the canal, thanks to the watchfulness and energetic action of all the canal employees, passed through this ordeal practically intact.

A Machine That Makes Its Own Repairs

THE other day we heard a man grumbling about the doctors. He roundly asserted that, as diagnosticians, they were but a sorry lot. "Something goes wrong," he said, "with a complicated machine in my factory or a delicate instrument in my laboratory. I call in a professional engineer or a skilled mechanic. He very quickly locates the trouble (that is to say, diagnoses the case); readjustments or repairs are made; and the worry is over. Now the body is a machine and the doctor is the professional engineer. He has spent a lifetime in the study of this machine; and he has at his disposal all the accumulated experience of his profession for ages past. Something goes wrong with this machine. You call in the doctor; he diagnoses; prescribes medicine, diet, etc. You follow instructions faithfully; but with no results. You try another doctor—same result. You go to a specialist; to two or three of them, and you are lucky if you don't collect as many different diagnoses and end up on the operating table. No, take it from me, the average doctor, as the professional engineer of this machine we call the human body, simply isn't in it with the mechanical engineer in finding what is wrong with a machine and setting it right."

Then we pointed out to our friend that to compare the most ingenious and perfect mechanism ever made by man with the human body, was as foolish as to place his baby's go-cart in the same class with a Rolls-Royce motor. We asked him to consider that although the modern high-class automobile in respect of the ingenuity of its design, its power, durability, speed and ease of control, may be regarded as the most perfect mechanical triumph of the age, it is but a child's toy in comparison with that crowning triumph of all creation, man. Not only is this body of ours a heat engine, with an efficiency undreamed of in any heat engines of man's construction; but it is a self-contained chemical laboratory, in which are carried on, ceaselessly and surely, scores of differing elaborate reactions for the production of the substances needed for the growth and repair of the body.

For one point in which the man-made machine may go wrong there are a thousand where this infinitely complex human machine may slip into trouble. We bade him be fair to the doctor by recognizing the infinite complexity of the problem of making the right diagnosis in a complicated human disease.

And then, to drive in the last nail of conviction, we dwelt upon the marvelous fact, that the human machine is self-repairing. To match that, the automobile would have to be capable of building up the walls of its cylinders, the surfaces of its piston rings and the seating of its valves, continuously, and in the exact measure in which they were worn away. And as for the tires, they would have to fabricate new rubber on their treads as these were ceaselessly disintegrated; and when a deep gash was cut in the shoe, molecule by molecule new rubber would have to be built up by the tire itself, automatically, until the wound was wholly closed.

Although it is true that but for this marvelous power of self-repair, the doctors and surgeons would, indeed, be in a hopeless quandary, we may at least be assured of this: that the most difficult repair job in a garage or a factory is simplicity itself compared with repair work in a hospital of sick men.

Here and There

AMONG the most weighty of the Federal Government's activities, and far from the least interesting thereof, are those of the Public Health Service. Few of us realize the extent and the wide variety of the work undertaken by this bureau. Many of us, even, are quite without any adequate concept of the wide field over which the public health engineer today must spread his labors. With no pretense of covering this field, but merely to indicate some of its more interesting angles, "Here and There" this month is given largely to a display of several interesting personalities and several interesting undertakings of the Public Health Service.

SOME of us live to eat, and others eat to live. Individuals of whom the former may be said are fairly well confined to the human race; but of those organisms who make the absorption of nourishment a mere prerequisite to living rather than the chief aim and ambition of life, we humans are a distinguished minority. The dark gentleman of the adjoining picture serves meals every day to a population vastly exceeding the sum total of the world's human inhabitants. He is "chef" to the colonies of bacteria maintained in the laboratories of the Public Health Service. L. J. Bender is his name, and every day he prepares some 6000 tubes of soup-like material, of one sort or another, for his minute charges. The finest steak, eggs, potatoes, gelatine, milk and other edibles coming within our own understanding of the term are employed, together with numerous chemicals necessary for the life of the germs that eat them, and falling rather outside our own dietary field. The statement that Mr. Bender feeds a clientele far surpassing the human total follows from simple multiplication. The tubes of which he puts up so many during the course of his day are designed to feed, on the average, ten billion bacteria each. We don't want to put an undue drain upon the compositor's supply of zeros, so we leave it to the reader to find for himself how many residents of Uncle Sam's bug hotel are fed from Mr. Bender's unique kitchen.

ANOTHER interesting job in the Public Health Service is that of Dr. E. T. Wherry, whose portrait adjoins in the corner of the page. To Dr. Wherry falls the task of attempting the purification and, presumably, the ultimate isolation of the important vitamins; and obviously he is called upon in the ordinary course of this work to make a great many identifications of chemical substances which he finds in and isolates from the materials upon which he is working. Ordinarily, chemical analysis or chemical identification, without some pretty definite lead that suggests what to look for, is a pretty long-winded task. Give the chemist a white powder and ask him what it is; and if you withhold all information which might serve as the basis of a shrewd guess that would indicate what he may most hopefully try first, it is largely a question of good luck whether his answer will be reached in an hour or a week. But this is too slow for Dr. Wherry's work; an answer must be forthcoming more quickly. So optical methods are resorted to, and instead of analysis through test tube and retort, he uses the spectroscope and the microscope. He is shown here, working with a petrographic microscope. This instrument was designed in the first place for use in optical analysis of rocks; but by working with immersion oils



Dr. E. T. Wherry

of various types, it makes it possible for Dr. Wherry to get a very rapid qualitative analysis of other substances, the optical properties of the specimens varying in such a way as they are passed from one oil to another as to give their composition away very rapidly.

NO particular danger attaches to the work of Mr. Bender and Dr. Wherry. But the label "Public Health" must remind us of medical martyrs who have given their lives in the investigation of deadly diseases; and since all the deadly diseases are not fully investigated, it follows that there must still be done some of this sort of thing. The most perilous work being carried out by the Service right now is rather unsensational, compared with the attacks of past years upon yellow fever, malaria, and other spectacular plagues. This time it is nothing more theatrical than the effort to control a poisonous wood tick which infests certain regions of Montana, making these largely uninhabitable by virtue of the fact that its bite is usually fatal to humans. *Dermacentor andersoni* is the name of the little pest; and L. R. Spencer is the name of the doctor, portrayed herewith, who is conducting the assault upon him. By way of vivid proof that the work is dangerous, we are informed that two members of the Public Health Service and one of the Rockefeller Institute have already met their death at the hands of the vicious dermacentor. Dr. Spencer's particular undertaking is the search for a serum that will confer immunity against the tick's bite. Experiments are progressing with rabbits and guinea pigs, and Dr. Spencer is about to transfer the scene of his experiments to the infested region of Montana, bearding the lion in his den, as it were.



Dr. L. R. Spencer

SQUINTING through the microscope at some strange or familiar carrier of infection is by no means the extent of the Service's contact with bugs and bacteria. They have a regular staff artist, whose whole job consists in making large-size drawings and paintings of germs that are invisible to the public eye, and other creatures of similar sort. One of his recent productions was a large painting, in natural color, of the common stable fly, who is eligible for this treatment at the hands of a germ artist because he is alleged to be the carrier of the infantile paralysis infection. Professor Wilder—pardon our neglect to introduce him; L. H. Wilder is the name, and at the top of the third column you will find the portrait—had to use up no less than fifty files in making this particular bug picture, because they are so fragile that they cannot be protected against accidental damage. Professor Wilder's masterpieces are employed alike in serious study, and for purposes of propaganda and public education. His work is a phase of Governmental activity pretty far removed from our grandfather's concept of public business!

SEVERAL years ago there was developed in England a process for dyeing in two colors, in patterns, with a single dipping. This apparent contradiction is resolved into common sense when it is explained that the fabrics for such treatment were woven in silk and cotton materials combined; dyes being used which would "take" on cotton but not on silk, and vice versa. The goods being dipped in a mixture of two such dyes, one would color the cotton and one the silk, and the desired effect was produced. But the applicability of the system was greatly circumscribed by the scarcity of dyes which would affect the one substance completely, and leave the other absolutely untouched; and which at the same time should be commercially fast. Subse-

quent research, however, has been conducted in cooperation between cotton and silk makers, each seeking dyes that would apply to his own product and leave the other uncolored; and a wide variety of these is now available—no less than seven hundred odd. It is therefore now possible to use the double-dyeing process for a very wide range of effects, instead of being limited to about six simple colors as has heretofore been the case; and the process is regarded as of prime importance to the weaving and hosiery industries of Britain. The statement, with its suggestion of rainbow hose dyed at a single dipping and therefore within the reach of the modest purse, is sufficiently alarming!



Prof. L. H. Wilder

DRYOPITHECUS, or forest ape, is the name of the latest aspirant for rank in the genealogical list, to which Mr. Bryan offers such violent exceptions, connecting man with the lower animals. He lived in the hills of India, in Miocene days. His remains—such of them as we have—were discovered by Mr. Barnum Brown, one of the most indefatigable of explorers, who is on the staff of the American Museum of Natural History. He was a big fellow, the size of the gorilla. The elevations and furrows on the crowns of the teeth follow so closely those of the Neanderthal man that Drs. W. K. Gregory and Milo Hellman, of the Museum, are inclined to regard dryopithecus as the closest approach yet found to the ancestor of the entire family of apes and humans. There are similar parallelisms between the teeth of the forest ape and those of certain Australian peoples, and others who are among the most primitive of existing humans. Dental comparison must be made on this basis, because the civilized white and yellow races have without exception lived for so many years upon a diet largely agricultural that great alterations in their teeth have taken place, masking their original characteristics completely.

THAT utter recklessness in the diagnosis and treatment of disease is not countenanced, even under the loose license laws that permit the practice of various nondescript schools of treatment, was demonstrated in April in New York. A practitioner of what must be regarded as among the most respectable varieties of these medical hangers-on was called in to treat a little girl who, in point of fact, had diphtheria. The freak-opath never found it out until it came time to apply for a death certificate, which very fortunately was the one thing that he could not supply himself. On the very clear basis of the post-mortem diagnosis, plus the statement by the attending practitioner that he did not know what his patient was suffering from, a conviction of manslaughter was secured against the man whose mishandling of the case prevented the calling of a real physician until too late.

CHEMISTS from all over the country are gathering at Washington, as we write, for the spring meeting of the American Chemical Society, which will run from April 22nd to 26th. The keynote is to be given in two addresses of the opening day: "The Atom as Seen by the Physicist," by R. A. Millikan, Nobel prize winner and long-time Professor of Physics at Chicago; and "The Atom as Seen by the Chemist," by G. N. Lewis, Willard Gibbs medalist and Professor of Chemistry at California. In addition to the discussion of atomic physics and chemistry, other topics which will loom large on the program will be industrial chemistry, alcohol manufacture, and helium production. There will be a spectacular display of the progress of chemical warfare.

Telepathy and Radio

Results of the SCIENTIFIC AMERICAN Test of Thought Transference from the Broadcasting Studio

By J. Malcolm Bird



ALTHOUGH the formal work of our Psychic Investigation Committee lies wholly in the field of the objective, the subjective side of the psychic picture is of sufficient interest and importance to justify periodic reversion to it. So when opportunity presented itself to make an experiment in telepathy, upon an unusual scale, through the WOR broadcasting station, we seized it. The general idea was for the members of the broadcasting group to fix their attention upon simple words, pictures, ideas, etc.; and for the members of the radio audience to try to reproduce these. This, of course, is the traditional technique of telepathy experiments; the only novel feature was the use of the radio.

The philosophy that dictated this choice of medium has been much misunderstood. There is temptation to argue that telepathy must be effected by transfer of energy from brain to brain; and once we have said this, we are bound to talk about waves, and to draw analogy with the light wave and the radio wave. Now it would be among the *a priori* possibilities that telepathy is an electromagnetic phenomenon; and in this event there would be good prospects that the radio wave might act as a "carrier." But it was not for this reason that we worked over the radio.

The fact is, with telepathy as with other psychic manifestations, those in best contact with the phenomena are inclined to regard them as relativistic in their *modus operandi*. That is, they are looked upon as something to which the ordinary categories of time and space are not applicable, so that the attempt to formulate them in terms of these classical concepts would be as futile as though we were to try to define the color of a sound wave or an electric current. If this idea is correct, there is no reason to anticipate that the presence of the radio wave would have any effect, good or bad, upon the attempt to communicate telepathically.

Telepathy vs. Guessing

Now this attempt is easily made, but to estimate the success attained is highly complex. Suppose that I think of the name of a certain city, and suppose, for statistical exactness, this be one out of a list of fifty. Suppose I ask you to try to duplicate my thought. Obviously, in response to this, the name of one of these 50 cities must come into your mind. If you don't get the right one telepathically, you must get the right or a wrong one out of your own psychology. If you were an unthinking machine, we should know that the chance of your naming any particular city was exactly one in 50. But you are not an unthinking machine; you have associations with some of these cities that bring their names into your mind more easily than those of the others. How then are we to estimate the chance of your naming New York or Galveston rather than Albany or St. Louis?

When we come to actual scoring of a series of such tests, this factor works both ways. If my choice runs toward cities that are natural psychological choices for you, you will score more hits than you are apparently entitled to, and I shall suspect you of telepathic sensitivity when you are innocent of this. If, on the other hand, I habitually name cities that are unnatural for you to name, your guess-work score will be so low that you may actually have considerable telepathic success without running sufficiently over the apparent mathematical probabilities to attract my attention.

The mere fact that we must get a lot of data before we can apply the theory of probability, plus the complication which comes from the addition of psychological probabilities to mathematical ones, requires that we experiment a great many times with the same subject, or experiment once or oftener with a great many subjects, before we attempt to formulate results. The radio affords a means of experimenting simultaneously with a very large number of subjects, so that a significant array of data may be got together in a minimum of

time. And of course, it also affords a very promising possibility of uncovering a few noteworthy telepathic sensitives. Of the hundreds who respond, few, if any, have any idea whether they are sensitive or not. Of those who get several items right on the list of a given evening, further individual investigation may identify one or more as promising material for further work.

Though this test was engineered by the SCIENTIFIC AMERICAN as such, and not by our psychic committee, we had the cooperation of Drs. Murphy and Carrington of the committee. At a previous test in Chicago, by Dr. Murphy and others, there had been a battery of forty-odd "senders." The idea was that we don't know what constitutes a good "sender," so the bigger the crowd the more chance of getting at least one good one. But with so many present, the numbers, words and pictures whose transmission was being attempted had to be posted on a blackboard, where the reporters, among others, could see them. Though pledged to secrecy, the gentlemen of the press began publishing the correct answers at noon on the following day; so all replies post-marked later than this had to be discarded. In our own case, we decided to operate on a

ing, since the mathematical probabilities of a correct guess were but one in a thousand. The number had been picked at random, off a letterhead; we were confident that it possessed no favorable or unfavorable psychological angles. We were interested, however, to note that the only number getting more than one or two votes was 999, with more than a dozen. This is doubtless because the more or less "occult" character of this number brings it easily to the mind, especially of people having some interest in occult things. The same number dominated in the answers to the Chicago test.

One might incline to attach importance to answers that give one or more digits, correctly and in correct place. Now I have a conversational trick of illustrating my remarks by a numerical example, with a definite number, chosen at random on the spur of the moment; and I have long been conscious that in these numbers there is a heavy over-proportion of sixes and sevens. The Chicago tests ran heavily toward sixes; and there can be no doubt that in the general case, certain digits are psychological and others unpsychological. So conclusions regarding digital success should be drawn with much reserve.

The importance of avoiding a heavily psychological selection of the item for transmission is well illustrated here. Of those who answered "999," all would presumably have given this answer whatever our number were. Where should we have stood in rating this test, if our number had been 999?

For our second test, we used the outline map of one of the 48 States, asking the audience for an identification. Though chosen at random from a pile, Indiana turned out to be an unpsychological selection; of 470 answers, instead of ten correct ones we got but two, while of those who availed themselves of the opportunity to name two items if they got two approximately equal impressions, three gave Indiana with another State.

Now one picking a State out of his own psychology will usually hit the State of his residence or an adjoining one; or if he dodges this pitfall, he is very likely to take flight in fancy clear across the continent, coming down in Florida or Texas or California. Indiana then occupies an in-between position, and is an unnatural choice.

Test 3 was double-barreled. We used the front-page head and date-line from one of the New York newspapers, with the advertisement of a certain department store. We asked the audience to name the paper (the *Times*) and the store (Saks).

Here, obviously, unless one displays real strength of character, one will name one's usual paper and one's usual store. In any event, a lot of people must have the paper right, since there are few alternatives; so it is not at all surprising that 78 respondents out of 448 named the *Times*. The mathematical and psychological probabilities would depend upon numerous factors; but if these were estimated, they would give a figure not far removed from the actual score. There is a distinct drawback in using a test for which the possible choices are so restricted. Any small number of telepathic successes is bound to be swallowed up and lost in the statistical nature of the case; and one hardly expects enough telepathic successes to alter the score materially from what chance would dictate.

Examples in Psychology

The choice of Saks was, of course, an unpsychological one—in fact, deliberately so. The three stores with the largest clientele are undoubtedly Wanamaker, Gimbel and Macy; and I purposely avoided these. By far the larger part of the replies was divided among them; Saks was named only three times.

For the fourth test, I shielded my watch from my eyes and turned its hands rapidly and at random. The four senders concentrated on the time at which it stopped, and tried to put this across to the audience. This test was certainly free from psychology in the

(Continued on page 433)

THE SEARCH FOR TELEPATHISTS

Test Number	Correct replies	Chance of getting another correct answer	Subjects who should have another by chance	Subjects who did have another
2	2	.48	1	1
3A	78	.37	29	17
3B	3	.48	1	0
4	3	.48	1	0
5A	8	.47	4	3
5B	100	.31	31	31
5C	25	.45	11	16
5D	11	.47	5	4
6	3	.48	1	1
7	14	.47	7	5
8	9	.47	4	3
Totals.....			86	74

The above table summarizes the results of the examination of the returns from those subjects who got more than one test right. It shows that the people who got one test right displayed, in general, no more tendency to get something else right than did the bulk of the respondents. The exception to this in the case of Test 5C is given an increased potential significance by the fact that it was this test which, considered on its own merits, most strongly suggested that telepathy may have been at work. The figures in the column "chance of getting another correct answer" represent the fractional probability of success in one attempt; with the omission of the decimal point, they would represent the probable number of successes in 100 trials.

basis that would insure secrecy in the studio; so we used four senders, against all of whom some suspicion of telepathic sensitiveness might fairly be held.

Trying to Telepathize

The procedure was simple. Speaking into the transmitter, I said: "For the first test, the members of the broadcasting group are concentrating upon a certain number between 1 and 1000. The members of the audience will try to get an impression of what this number is." The number in question (522) was written large on a slip of paper; and during my remarks and for some seconds after, I and my collaborators concentrated visually and mentally upon it. Of eight items on the program, one was double-barreled and another involved four separate answers; so that in all, there were twelve opportunities afforded the members of the audience to be right or wrong. At the end, they were asked to mail their memoranda of their results to me; and 480 of them did so. The number would have been larger, had it not been for competition with two other local broadcasting programs; one cannot get undisputed possession of the New York air at any rational hour of the day or night.

Through failure to receive or to understand the question, or to get any definite impression, there were numerous blanks on single tests, so that the number of answers tabulated varies. Of 457 replies to the first test none gave the correct answer. This is not surpris-

Our Abrams Investigation—IX

Results of Tests with Genuine E.R.A. Apparatus and Genuine E.R.A. Technique

By Austin C. Lescarbourea

Secretary to the Scientific American Abrams Investigation Committee

FOR the past four months or more certain electronic societies and associations have been engaged in forming special committees and formulating conditions to the end of actively cooperating

with us in our investigation of their methods. Long before now we were given to understand that carefully selected electronic practitioners would be assigned to the task of undergoing our simple tests. Indeed, with a view to facilitating such cooperation, we went so far as to outline the probable nature of our tests, with the result that many of the electronic workers tried similar tests and determined for themselves just how scientific their methods were and how much they could hope to prove before an impartial body of investigators.

Meanwhile, time flies. Month after month goes by. We are asked to wait for this and wait for that. We are told that the technique is not quite perfected to the point where our simple tests can be undergone with a fair degree of certainty as to results. Also, we are warned again, the E. R. A. and other electronic workers must be assured that we are really sincere investigators before they can entrust their work and their reputation in our hands. And so it goes.

But this committee, engaged for the past eight months in investigating the startling claims of the late Dr. Albert Abrams of San Francisco, and his thousands of followers both here and abroad, cannot wait indefinitely. Were we asking for some highly intricate demonstration of electronic technique, there might be fair cause for delay; but when it is borne in mind that we ask merely for a simple check-up on everyday electronic diagnosis, the case is quite different.

If, in the opinion of the electronic workers, their methods are insufficiently developed at this time to pass a most elementary test such as we propose, then in good faith and through honesty of purpose they should, without further delay, suspend their present electronic practice. They should tell their patients that they are not sure just what they are doing. After all, human life is too precious to be the subject of raw experimentation or something worse than that, as the case may be.

All the while, our committee proceeds in the quest of truth. During the past few months we have been in constant touch with a group of doctors engaged in studying and applying the electronic reactions to their own technique and practice. These doctors, who are well known but whose names are withheld in accordance with our practice in this investigation, have taken the authorized Abrams course of instruction in San Francisco and are equipped with the genuine Abrams apparatus. For the purposes of our series of tests, they followed the simon-pure Abrams technique. Although these same doctors are the sponsors of an impressive report which endorses the basic claims made for the Electronic Reactions of Abrams—a report, by the way, which is being

widely used and misused by the E. R. A. men—they have displayed the utmost willingness to cooperate with us in every way because they themselves are still engaged in experimentation. As the result of our series

would be the smallest number that would enable him to guard sufficiently against the operation of chance. He also recommended that of the six, three be identical while the other three be "singles," differing among themselves as well as from the identical ones. Any other course, he advised, would greatly complicate the mathematical control of the tests, without yielding compensating advantages.

From six specimens three may be chosen in exactly 20 different ways. Of these 20 combinations, one and only one, obviously, will comprise the three of identical origin. Nine of the remaining combinations will associate two of the identical specimens with one of the "singles";

and the remaining ten combinations will consist of specimens, no two of which are in fact identical. Speaking mathematically, then, and assuming that the choice is governed by chance alone, if this test

were repeated 20 times, there should be one complete success, nine partial successes, and ten total failures. If we try the thing 20 times or more, we may expect that this ratio of 1:9:10 will be approximately realized. If we try it just a few times, we may expect that we will get perhaps one full success, but hardly any more than that; while the rest of the trials will be split about evenly between complete and partial failures. The electronist must get considerably more than one full success per 20 trials, and very much more than nine partial successes per 20 trials, before he will have done anything tending to support his claims.

Complete electronic diagnosis involves the recording of the ohmages for a large number of rates. The identification test, however, may be confined to such few selected rates as the electronist judges to be sufficient to distinguish between two individuals. The alleged sex rate, which is claimed to be found on the reagent's left side for a female subject and on his right for a male, will naturally be one of these. In addition to it, the doctors with whom we were working chose the rates 42, 50, 55, 57, 58 and 60 as an adequate set. In this test, of course, no reference need be made to the alleged pathology of these rates under the Abrams system.

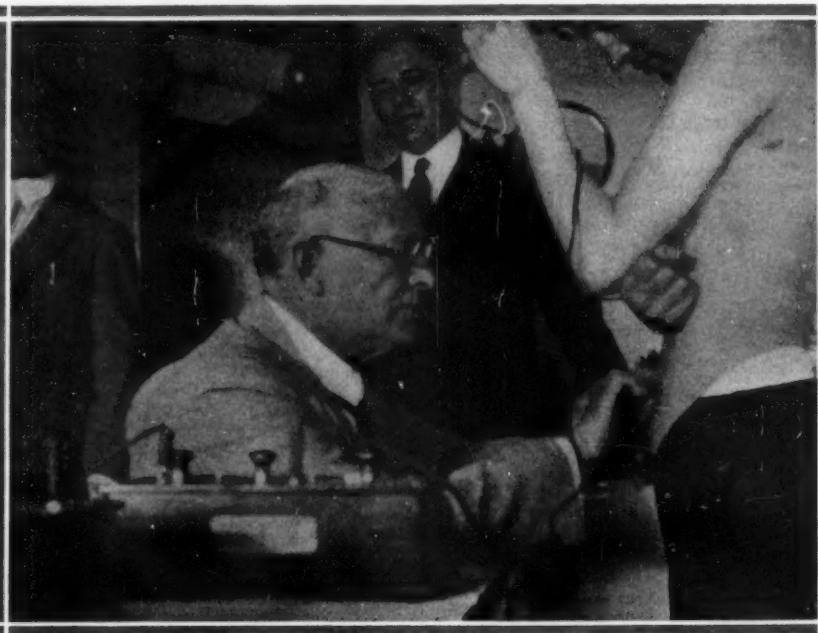
A series of tests consists in the determination of ohmages for the six rates and location for the seventh, for all six of the specimens provided. Series I, II and III were prosecuted on the first day, with a set of blood specimens provided by the health authorities of New York State, through the courtesy of Dr. William H. Park. At the second meeting a single Series, IV., was carried through, with specimens provided by the electronic experimenters themselves. Series V and VI occupied the third day, with a fresh set of specimens provided by the doctors.

In every instance the specimens carried blind identification numbers. In Series I to IV, nobody present knew which specimens were identical until the key was consulted at the end. On the final day, Mr. Bird consulted the key list from time

(Continued on page 436)

Tabulated Readings for Blood Specimens in the Attempt to Group Those of Identical Source

RATES	SERIES I Specimens			SERIES II Specimens						SERIES IV Specimens						SERIES V Specimens						SERIES VI Specimens					
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
	1	4	5	1	2	3	4	5	6	3	4	5	2	1	6	2	4	6	3	5	1	4	3	6	1	6	2
57	22	22	21	44	4	4	14	13	29	12	11	11	11	33	12	24	32	21	32	34	34	21	23	33	21	21	20
55	0	2	0	11	4	4	4	1	13	12	2	2	1	1	1	11	11	1	12	23	22	11	13	11	4	3	2
58	0	2	0	6	3	2	4	1	4	3	1	2	2	0	2	0	3	2	3	1	3	0	0	0	1	1	1
50	1	0	1	1	1	1	2	1	15	1	0	0	0	2	0	0	1	0	0	0	2	0	0	0	0	0	0
60	4	4	4	4	1	3	1	2	19	2-25	2-25	1	3	3	1	7	3	1	3	2	4	1	1	1	2	3	3
42	3	1	2	1	2	1	1	1	3	0	0	0	0	1	2-25	0	0	0	2	1	3	0	0	1	0	2	0
49	L	R	R	L	L	L	L	R	R	R	L	L	L	L	L	L	R	L	R	L	L	L	R	L	L	L	R



The late Dr. Albert Abrams diagnosing a patient's condition from a blood specimen by means of resistances boxes and the abdominal reflexes of a boy reagent

same bloods." And that statement speaks volumes.

Once we had agreed with these doctors upon the abstract proposition of a test in which they would attempt to identify blood specimens of common origin,

Rearrangement of the Figures for the Purpose of Facilitating a Check-Up

RATE	IDENTICAL SPECIMENS												ISOLATED SPECIMENS											
	SERIES I, II, III						SERIES IV						SERIES V, VI						SERIES I, II, III					
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 3	No. 4	No. 5	No. 6	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 1	No. 2
57	22	44	4	21	13	23	12	11	11	11	34	21	32	23	21	33	4	13	22	14	24	29	14	24
55	0	11	4	0	1	0	12	2	2	2	22	4	12	13	1	11	4	1	2	4	15	13	3	11
58	0	6	3	0	1	1	3	1	2	2	3	1	3	0	2	0	2	1	2	4	1	4	1	0
50	1	1	1	1	1	1	1	0	0	0	2	0	0	0	0	0	1	3	0	2	1	15	1	0
60	4	4	1	4	2	4	2-25	2-25	1	4	2	3	1	1	1	1	3	3	4	1	1	19	1	7
42	2	1	2	2	1	1	0	0	0	3	0	2	0	0	1	1	1	1	1	1	3	2	0	0
49	L	L	L	R	R	R	R	L	L	L	L	R	R	R	L	L	L	R	L	R	R	R	R	L

we called upon Mr. Bird, as the staff mathematician, to define the procedure. Obviously, the fewer specimens we use in the test the more often we can carry it out in a given time; and Mr. Bird advised that six specimens

IV, nobody present knew which specimens were identical until the key was consulted at the end. On the final day, Mr. Bird consulted the key list from time

Getting Together on the Traffic Problem

The April Conference, at Yale, of Those Expert in All Its Branches

By the SCIENTIFIC AMERICAN Staff



ONE of the first impressions that one gets from any survey of the motor traffic problem is that of its complexity. The mere statement of the problem is almost a sufficient indication of this complexity. Further evidence is given by the extraordinarily diverse treatment which different States give the same point;

and by the extraordinarily diverse content of the motor codes of the several States, many of them touching in great detail things which are not at all the subject of legislative enactment in others. Then we have the Motor Vehicle Commissioners of ten eastern States, after several years of close association and contact in an organization whose whole business is the attainment of uniformity, totally unable as yet to agree among themselves as to the best means to certain necessary ends.

Such a complex problem is to be resolved into its elements, if at all, only after a great deal of open discussion by a great many very competent people; and after a great deal of publicity. A long step in the attainment of both these ends was taken in the conference on Motor Vehicle Traffic, held at New Haven under the joint auspices of Yale University and the State of Connecticut, April 9th to 11th.

According to the statement made in the invitations sent out, the purpose of the conference was to consider the causes of accidents due to motor vehicle traffic, and to discuss methods for preventing such accidents. The machinery of the conference consisted in addresses followed by general discussion. The first day's program revolved about a study of the conditions and a statement of the problem. The keynote address, and at the same time the most important single contribution, was delivered by Professor John C. Tracy, of the Department of Civil Engineering of Yale University. Professor Tracy and his colleagues were called in some time ago by Commissioner Stoeckel of the Connecticut Motor Vehicle Department. The Commissioner's office, since the installation of the compulsory reporting of accidents which we described in the SCIENTIFIC AMERICAN last month, had accumulated data regarding 15,000 accidents. The big feature of this was that the accident roll involved was complete—they were not accidents selected out of a larger total, but included all Connecticut's accidents for three years. The Commissioner's office knew that there was great value in this mass of statistics, but did not know how best to get it out; and every attempt that they made to analyze their figures led them into worse uncertainty. Did the figures mean this, that or something else? Finally they got the Yale engineers on the job, and the result was a really brilliant analysis, and the most striking graphical presentation which we have ever seen given to a mass of data of comparable size. Professor Tracy's talk and the ensuing discussion took up a whole morning, and nobody begrudged the time.

For the afternoon of the first day, there were two addresses. Judge W. M. Maltbie, of the Superior Court of Connecticut, talked about "Laws Governing Traffic"; and T. W. Salmon, Associate Professor of Psychiatry at Columbia University, discussed "The Mind of the Operator." The titles define these papers sufficiently for present purposes, so no further comment is made upon them, other than to remark that Professor Salmon's theme, the uncertainty and the fallibility of the human element, ran through the entire conference, and was stressed by many speakers as constituting a dominant aspect of the whole traffic problem.

The character of the accidents that are occurring, the character of the regulation that is being attempted, and the character of the human mechanism involved in the driving of the car having been duly placed on record, the second day of the conference was given over to talks dealing more or less directly with the ways and means of prevention. A. B. Meredith, Commissioner of Education of the State of Connecticut, discussed the remedial value of education, as applied to the child. E. G. Payne, Professor of Education at New York University, took a more general view and outlined the value of education applied to the general public. Both these speakers stressed the fact that the habits and customs of a former day, which are more or less ingrained in us, are unsuited to the present era, and that we are unsafe on the public ways in direct

proportion to the extent to which we permit these habits and customs to control us. In the child, it becomes actually necessary to overcome tendencies of biological origin before the menace of the automobile can be eradicated. The importance and the diversity of this element, one must conclude after listening to these two addresses, is seldom if ever realized by the world at large. We must choose between our cars and our fathers' habits of mind.

The subject of education having been thus covered, Colonel F. S. Greene, Superintendent of the Department of Public Works of the State of New York, in charge of all road construction and maintenance in the Empire State, talked on "Highway Improvement." He pointed out, as we did last month, that while in a majority of accidents some reckless or improper or ill-judged act by the operator is the immediate cause, the fact that wrecks are not scattered freely and uniformly all along our highways proves that usually there is, in some physical feature of the road, a contributing cause without which the accident would not occur. And, as a road-maker, he is willing to shoulder the burden of removing these physical peculiarities, of making the roads as nearly fool-proof as they can be made. He gave in considerable detail the essential characteristics, as he sees them, of a road that shall be safe for automobiles traveling at speeds of 35 and 40 miles per hour. His paper was followed with the keenest of interest and attention—presumably because everybody has his own opinions about road-widths and curves and grades and shoulders and danger signs, and everybody wants to see how closely the expert approaches to his own high standard of intelligence. Incidentally the Colonel gave another demonstration, if another were needed, that experts don't always agree among themselves. He had driven from Albany to New Haven, and had seen several things on the Connecticut roads which he criticized as undesirable—at least one of them being among the most cherished innovations of the Nutmeg State's road-builders!

The afternoon of the second day was given to a paper on Traffic Regulation and Control by W. P. Eno of Washington, D. C.; one on Police Methods by A. F. Foote, Commissioner of Public Safety of the State of Massachusetts; and one on Laws and Court Systems by D. A. Adams, Secretary of the New Haven Automobile Club. Commissioner Stoeckel closed this session with a brief summary, and a recommendation that a permanent organization of the conference be effected. This is to be carried out.

On the third day, Commissioner Dill, of New Jersey, outlined the procedure of a motor vehicle department, as exemplified mainly by the things which his does, and in some lesser degree by those he would like to have it do. The balance of the day was given to problems peculiar to Connecticut; highways, street railways, public service motor vehicles, traffic policing of highways and traffic policing of city streets being the points discussed.

Much of the material brought out at the conference will be available, a little later on, for our use in the preparation of special articles going with considerable detail into the matters specified by the titles. For the present, we are content with this brief statement; because the conference was of such importance as to demand attention in this issue, and nothing beyond this brief statement can be prepared in the very short time remaining before we go to press.

Walking on Red Hot Stones

IN some parts of Asia the priests, in order to show their magical powers, walk on red hot stones. The stones are spread over a fierce fire and the men then proceed to walk over them without any protection to their feet at all. This achievement has always puzzled scientists a great deal for there is no doubt that the priests really do walk on the stones with bare feet and also that they do so without injury. Many times the feet have been closely examined after the ordeal and have not shown any signs of being burned at all.

It has been stated that the soles of the priests are much tougher than would be the case with men accustomed to wearing boots. No doubt this is true, but even the toughest skin would soon be burned by the fierce heat. The real explanation is very interesting and has only just come to light.

In the making of a fire a shallow pit is dug and in

the bottom of this is placed the wood. This is overlaid with several layers of round stones and the fire is lighted. When everything is apparently at a great heat the priest walks across, and gets to the other side quite unharmed. Any sceptical person who tries to do the same gets his feet terribly burned. It has been discovered that, always, at these times one kind of stone known as basalt is used. This is of volcanic origin and is extremely porous and moreover is one of the worst conductors of heat known. It is quite possible to have a lump of basalt red hot at one end and yet cool enough to hold in the hand at the other end. Thus the cunning priest knows exactly where to put his feet and as long as he actually avoids treading on the glowing stones there is no fear that he will get burned. Anyone who does not understand the trick would walk carelessly with very painful results.

The Locomotive of the Future

IT IS far too readily assumed, especially by non-technical people, that all the great railways will eventually be electrified. However, among the chief drawbacks to the realization of such assumption are the very high initial cost, approaching a rebuilding of the railroads, and the very serious risk of breakdowns, which may even paralyze the whole system, instead of a single train as with steam.

Viewed sentimentally, the heavy and cumbersome electric locomotive cuts an ignoble figure as a mere transmitter, not a producer, of power.

Can the ultra-reliable steam locomotive meet the challenge of this comparative newcomer for the domination of the iron road?

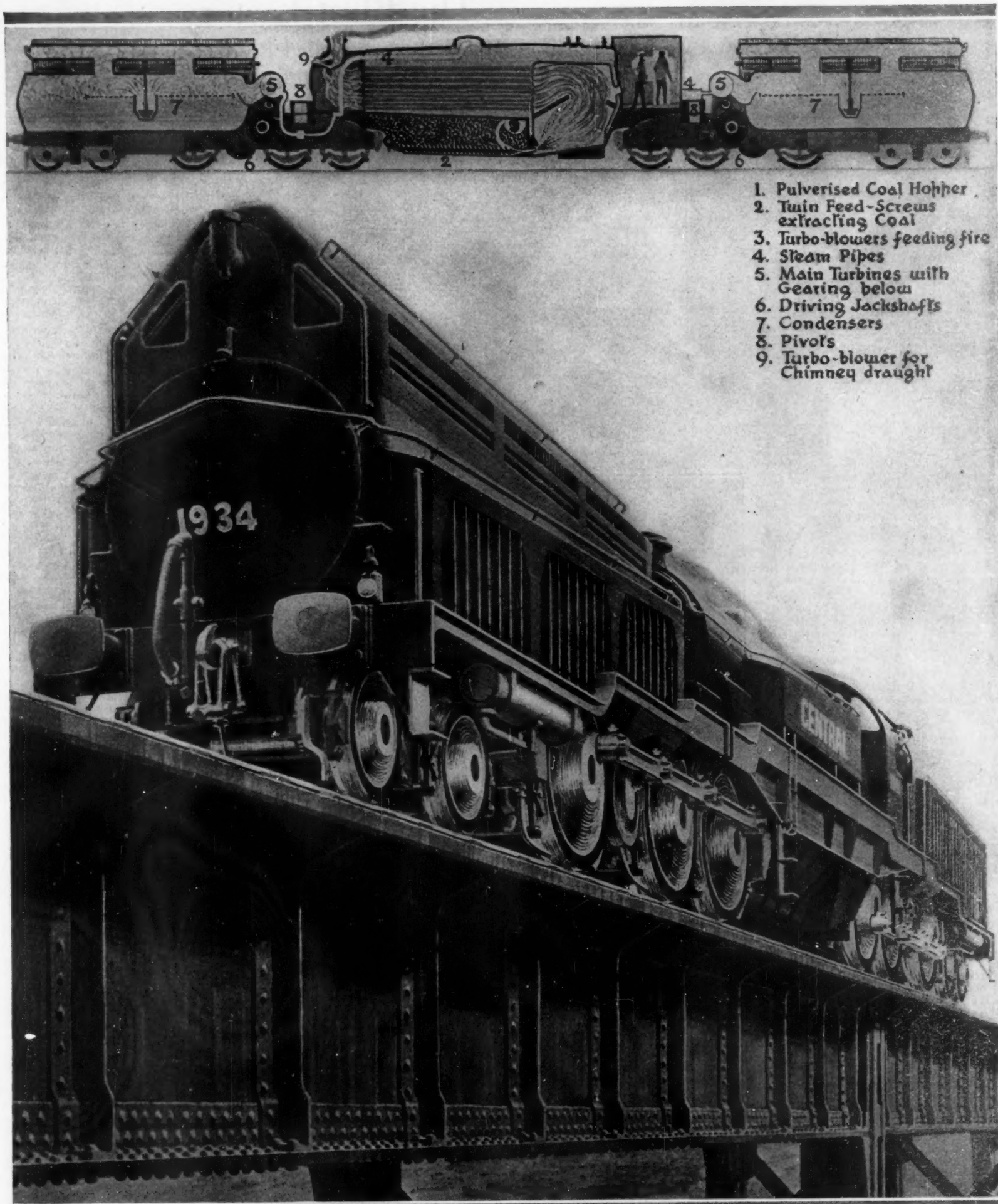
The simple steam locomotive of today is undoubtedly touching its limit, and is extraordinarily wasteful, putting only some 6 per cent of its heat to actual use. It has never previously had a condenser, as in other steam practice, which simply means extracting further service from the inadequately used steam by returning the condensate water, still heated, to the boiler. Compounding, also, has failed, being the using over again of the steam in a second, larger cylinder at a lowered pressure, these cylinders having grown too big, in the most powerful examples, for the limits of space.

However, the success of the Ljungström turbine-driven locomotive, recently described in these columns, has opened a vista of increased power and economy. This design, which employs a large condenser that disposes of the used steam practically in its entirety, and gearing to reduce the speed of the turbine to that necessary for the wheels, has equalled the results of equivalent standard locomotives on just half the fuel.

Further promise in the same two directions is held out by the articulated locomotive, which has two engines of the present reciprocating type under fore-and-aft coal and water tenders, and a central boiler section on a girder frame hung from two pivots, one above each set of coupled driving wheels. This type, first designed to negotiate sharp curves and steep gradients, has been highly successful in the British Colonies. Its power is much greater and its fuel consumption less, the boiler being broader and therefore more efficient, the fire-box, uncramped by the usual wheel axles below, larger and of better shape, while the articulation allows of greater length and steadier riding, with higher speeds round curves.

Finally, economy can be further improved by the use of pulverized coal, in which combustion is much more complete, with reduced smoke and ash and better steam-raising, the results equivalent to standard being obtained with inferior fuel, and mechanical stoking.

The prophetic drawing on the facing page depicts, in two views and a section, all these desirable features incorporated in one locomotive as a possibility of the future. Our artist's design is based upon the Swedish Ljungström Turbine Locomotive, the Garratt Articulated Locomotive, the G. C. Rly. pulverized coal burner No. 422, and feed from the front of the fire-box as in the Paris-Orleans oil-fired No. 4563. Such a locomotive would probably be 100 feet long, certainly weigh over 200 tons, would multiply the power of our present powerful locomotives several times, with only a relatively small increase in fuel consumption, and would haul several times the current train loads at express speed. Such an engine could, owing to the articulation, moreover, do all this quite as safely as existing engines, without any strengthening of track or bridges.



1. Pulverised Coal Hopper
2. Twin Feed-Screws extracting Coal
3. Turbo-blowers feeding fire
4. Steam Pipes
5. Main Turbines with Gearing below
6. Driving Jackshafts
7. Condensers
8. Pivots
9. Turbo-blower for Chimney draught

Drawn by our British artist, S. W. Clatworthy. Copyright U. S. A., Scientific American Pub. Co.

STUDY OF A TURBO-DRIVEN, CONDENSING LOCOMOTIVE OF THE ARTICULATED TYPE, FOR HEAVY EXPRESS SERVICE. IT INCLUDES A CENTRAL BOILER AND TWO CONDENSER TENDERS—(See facing page for description)



Bulk dynamite en route from mixing house to packing machines

APPROXIMATELY 326,000,000 pounds of dynamite were used in the United States during the year 1923, for upon the energy of explosives depends mining, quarrying and other basic industries. The manufacture of dynamite calls for raw materials from widely separated regions and

the application of scientific knowledge and skill to the problems of combining them into explosive compounds which will be safe and effective blasting agents.

The largest dynamite works in the world, located in this country, spreads out over thirteen hundred acres and includes plants for the manufacture of ammonium nitrate and nitric and sulfuric acid, and of the paper shells and wooden boxes in which the explosive is packed; storage magazines; the necessary facilities for power and transportation; and a laboratory for analysis, testing and explosives research, as well as seven complete units for the manufacture and packing of the various kinds of dynamite—straight nitroglycerin, ammonia, nitrostarch and gelatin.

The dry ingredients of dynamite include nitrate of soda from Chile, ammonium nitrate, wood pulp from Maine, flour, starch, kieselguhr, sulfur from Louisiana and Texas, and ivory nut scrap from the Caroline Islands via the button and bead makers who cut their wares from the center of the kernel and sell the scrap to the dynamite manufacturers to be ground into a fine meal and used as an absorbent. Some of these materials must be ground and screened before use and all of them are carefully dried.

The manufacture of the dynamite itself starts with the nitration of glycerin. This operation, like all others in the plant which are subject to explosion, is carried on in a house remote from other buildings and surrounded by wooden cribbed earth barricades. A weighed charge of mixed nitric and sulfuric acid, approximately 7000 pounds, is brought to the nitrating house in a tank car and blown up from the car by compressed air into the nitrator on the second floor, a wrought iron cylindrical tank standing on end with several pipes leading into its cover and on the inside two overgrown ice cream freezer paddles in the center and coils of lead pipes near the shell. When the mixed acid is running in, the paddles, operated by a small steam engine, are set in motion to circulate it around the brine coils so that it will be cooled to the proper temperature before the glycerin is added. Meantime the required quantity of refined glycerin, about 1400 pounds, is blown by compressed air from a heaving tank, where it is warmed to a temperature which will facilitate flow, to a scale tank in the nitrating house whence it can run by gravity through a rubber tube into the nitrator. When the acid is all in and cooled to the proper temperature the foreman takes his seat on a high stool near the nitrator, places the end of the rubber hose leading from the scale tank in a funnel in the cover of the nitrator and by means of a valve on the end controls the flow of nitroglycerin into the nitrator by hand. The glycerin runs first

The Blast Factory

From Raw Materials to Finished Product in the World's Largest Dynamite Plant

By H. E. Davis

into a perforated cast iron pipe just below the top of the nitrator and from this sprays down upon the swirling acid. The nitric acid combines chemically with the glycerin to form nitroglycerin and water, the sulfuric acid merely serving to facilitate the reaction and to take up the water formed. This reaction releases so much heat that unless it is carefully controlled there is great danger that the nitroglycerin will explode. Consequently the charge is continually agitated around the cooling brine coils, and the operator feeds the glycerin to the acid gradually, keeping an eye fixed on a thermometer extending up through the cover of the nitrator. The most favorable temperature for nitration and the maximum allowable temperature have been determined by laboratory experimentation, and vigilant supervision is exercised to see that charges are run within this range.

After the glycerin has all been fed into the nitrator a small quantity of kieselguhr and certain other substances is added to facilitate the separation of the nitroglycerin from the spent acids. When the green light shows in the signal box in the corner of the nitrating house, indicating that the separating house is ready to receive the charge, the foreman opens an outlet valve in the nitrator and gradually decreases

out of a painting by one of the old Italian masters. And indeed he seems, here in the dim quiet of his nitroglycerin separating house among the tree tops, solitary except for the presence of a single helper and the visits of superintendent and inspector, almost as much a recluse from the world as a holy man in some mediaeval monastery. In reality, he is performing day after day a highly dangerous function in the manufacture of a commodity upon which our whole modern civilization with its great industrial plants, its complex systems of transportation and communication, and its high standards of domestic comfort, depends. Twenty-nine years this man has worked on this plant and ten in this same house.

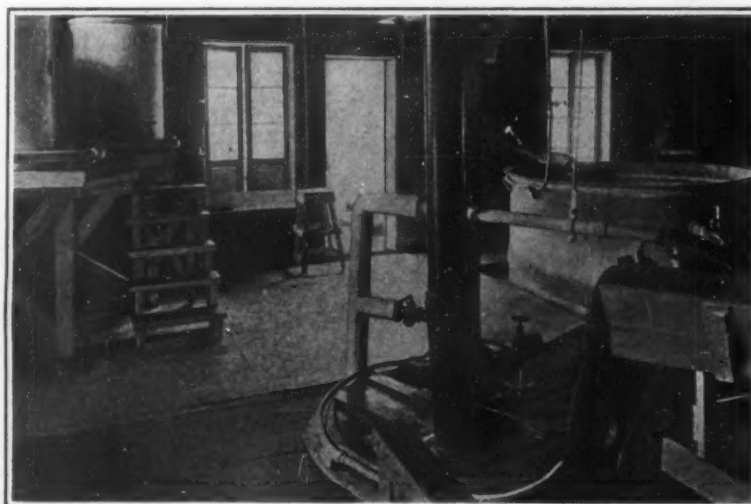
After the nitrator charge has run into the separating tub it is allowed to settle until a line on the sight glass in the side of the tub shows that the acid has sunk to the bottom and the nitroglycerin has risen to the top. The foreman continually watches the temperature of both liquids so that if the temperature of either rises above the safety point he can turn on compressed air in the bottom of the tub to start agitation or can run the whole charge into the adjoining drowning tub.

When the separation takes place without this emergency, as it generally does, the glycerin is drawn off into another tank and washed by agitation with warm water. It is again allowed to settle, the glycerin this time falling to the bottom, and then is run through the gutter along the plank walk which leads to the neutralizing house. The spent acid is likewise run from the separator into another tank and then blown to a storage house, whence it eventually returns to the acid recovery plant in the safety area. The acids are recovered, fortified and used again.

In the neutralizing house the n.g., as the nitroglycerin is generally called in the plant, is washed with a warm dilute solution of soda ash until it tests acid free, and is then piped into lead storage tanks on a platform along one side of the house. From these storage tanks a weighed quantity of nitroglycerin is transported in a rubber lined and rubber tired push cart to the dynamite mixing house. These n.g. carts are known on the plant as "angel buggies" and the men who push them are very careful not to exceed the speed laws, which call for a leisurely saunter.

In the mixing house are two dynamite mixing machines, each consisting of a bowl of wood lined with hard rubber, about ten feet across and a foot deep, in which stand two parallel, rubber-shod wooden wheels, about four feet in diameter, attached

(Continued on page 437)

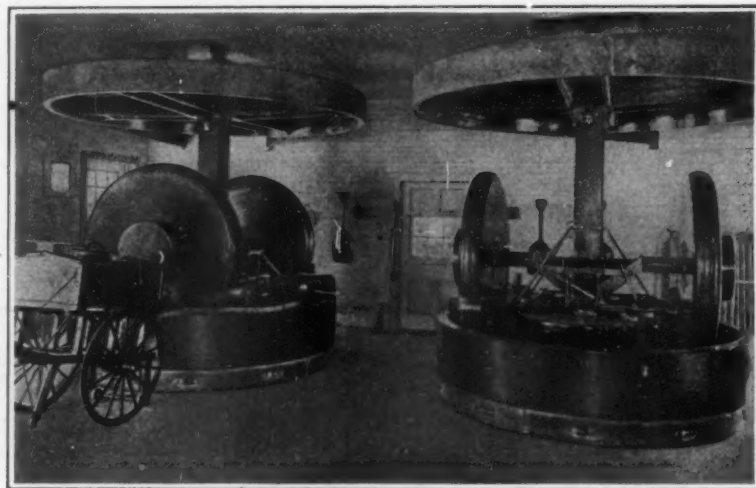


Separating house where the nitroglycerin is separated from the waste acid

the speed of agitation as the charge now flows out.

From this upper room of the nitrating house a board-walk on stilts, with a covered lead-lined nitroglycerin trough on the left and hand rail on the right, leads to the separating house about one hundred yards away.

This is the most hazardous operation in the plant but as one follows the narrow walk through the tree branchings with their leaves casting delicate shadows on the planks and a blackbird fluting melodiously in the sunshine, danger seems very remote and unreal. In the dusky interior of the separating house stands a seven-foot lead tub, and nearby, to keep close watch on the nitroglycerin as it runs in, the foreman. One separating foreman in particular always comes to mind when I think of this operation—a brown-bearded man with soft brown eyes. Clad in greenish brown trousers, blue flannel shirt and dark red sweater, all faded by long exposure to acid fumes into dull harmonious colors, he looks for all the world like a figure



The mixing house, where the liquid nitroglycerin is mixed with the "dope," making dynamite. Note "angel buggy" at left

Railway Ties of Concrete for India's Railways

A CONCRETE sleeper, or railroad tie, has been developed in India and used with success on the Bombay, Baroda & Central India Railway, as well as on the North Western Railway.

The sleeper consists of two concrete blocks joined together by an iron tie bar. The method of fastening the rails is by spiking into wood pugs, which are inserted in the body of the concrete block. The wood plugs are treated and dried down by a kiln process to a condition drier than the wood could naturally become, even in the driest desert areas of India. After drying it soon takes up atmospheric moisture and expands somewhat between and into the metal corrugations, placed in the concrete blocks, thus securely keying itself in. The plugs are compressed when driven and the efficiency of their grip on any form of spike—dog, screw or round—is much greater than in ordinary timber.

Each sleeper block weighs 165 pounds and the complete sleeper weighs 350 pounds. The concrete blocks are rectangularly ovoid in shape, rounded off in all directions and are without lugs, bolts or any upstanding parts liable to mechanical damage.

The sleeper needs very little surfacing or packing to maintain a good road, this being due to the steady influence of its weight and to the large bearing area on the road-bed.

The reduction of noise in any train when traveling from the ordinary wood road on to the concrete road is obvious to any passenger. It is estimated that the concrete ties, with the stone for the aggregate selected for its hardness and cured for 28 days under water, have a life of about 150 years.

Disappearing Searchlight Towers

THE sixty-inch searchlight used in seacoast work by the Corps of Engineers of the United States Army weighs with its electrical equipment about eight thousand pounds, and its light intensity is about one billion candle-power. With a view to concealment and protection when it is not in use, there has been designed by Mr. E. D. Cummings, Assistant Engineer of the Corps, what is known as a "disappearing searchlight tower." Our readers are familiar with the disappearing mount for our seacoast guns, which makes it possible to load and aim the gun below the protection of the parapet, and expose it to the view of the enemy only at the instant of firing. The new searchlight tower makes it possible to screen the light from horizontal observation by hiding it behind hills, mounds, trees, or even shrubs, and raise it into position only at such times and for such periods of time as may be desired.

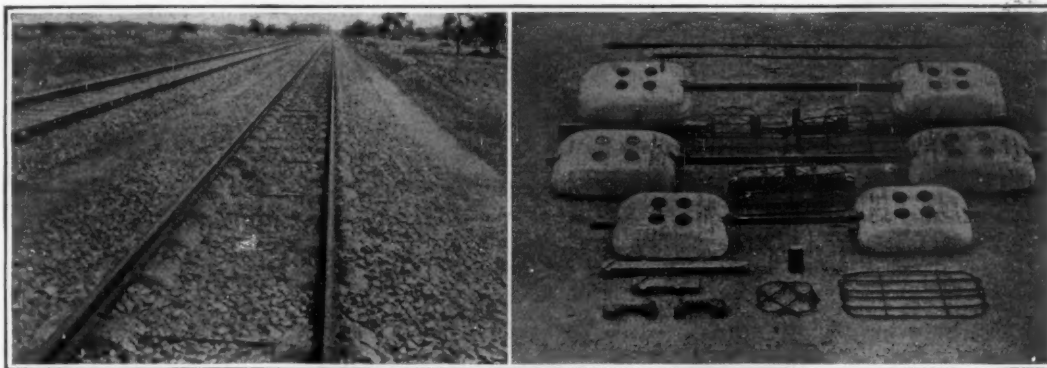
The towers vary from 45 to 100 feet in height. Each consists of a frame built up of steel angles, with two short arms at its top with a swinging platform between, at the center of which is carried the searchlight. Upon this platform the fixed portion of the base of the searchlight is firmly bolted down, and it is large enough for several men to move around the light and manipulate it in any direction.

Because of electrical considerations, it is desirable to have the rheostat convenient to the operator and hence the resistance sections are attached beneath the platform floor. The platform with its light and connections is so balanced that, whatever the angle of elevation of the tower, the platform will always be maintained in a horizontal plane.

The lower end of the searchlight tower is supported upon a trunnion shaft which journals on two A-frames, between which the counterweighted butt end of the tower swings. Each A-frame is braced by a third leg, and all three legs are securely anchored to a heavy masonry foundation. This butt end is counterweighted, mainly with concrete, which is cast into the steel frame and forms a rigid part of it.

To compensate for variations in the loading of the searchlight platform, small blocks of concrete or cast iron are provided and these make possible a very exact adjustment of balance. The trunnion shaft is keyed to the tower and its journals turn in bronze-bushed bearings on the A-frames. Particular attention has been paid to the matter of lubrication, and compression grease cups communicate with grooves in the journal which sweep the entire lower surface of the bearing in its rotation from the horizontal to the vertical position.

Great care has been taken to make the bearings self-aligning and non-binding, with the result that hand-power operation is easily effected; even the largest one-hundred-foot tower being readily operated by one man. The forty-foot tower may be raised or lowered by one man in less than a minute, and the one-hundred-foot tower by two men in less than two minutes. To



Left: Concrete railway ties in use. Right: Parts and reinforcements of concrete railway ties

avoid complete breakdown, the operating mechanism is in duplicate.

The balance of the operating platform at the upper end of the tower is such that it cannot overturn even with several men at one edge; but to prevent oscillation and maintain the platform horizontal under all conditions, the tower is provided with what is known as an "equalizer."

The tower can be securely held by brakes at any angle and these brakes can be padlocked in any position. Moreover, when in a vertical position, the tower can quickly be made a fixed structure with a rigid platform, independently of the brakes and the equalizer. It can be locked to the A-frames, and the platform anchored to the tower, simultaneously, by one movement of a lever at the ground. When elevated, the towers are quite rigid and stiff against wind effects. The moments of inertia of all the towers are relatively



Disappearing searchlight towers for seacoast defense

large and their centers of gravity quite near the ground.

When in the lowered position and not in use, the searchlight is enclosed within a small steel house, which moves on grooved wheels laid on the tower platform and on a foundation adjacent to the platform landing. When the tower is swung down, the house can be readily pushed forward on to the platform and over the searchlight. The curtain door is closed and fastened inside, and the operator locks the small rear door from the outside. With certain modifications this type of tower is used for a railway mount on a large flat car. On such a mount it will form an important element of the coast-defense railway artillery, possessing the same quality of invisibility.

The plans for this tower were designed by Mr. Cummings in the course of his governmental work and the development of these structures was initiated under Colonel E. E. Winslow, Corps of Engineers, United States Army.

The Nerves of Plants

THE general similarity of the distribution of the fibro-vascular bundles in plants and that of the nerves in animals have been clearly noticed. These structures in plants have, consequently, been called nerves. However, anatomists and physiologists alike have long held the view that the likeness is merely superficial, and is not based on any real physiological or anatomical resemblance.

In plants—as in animals—the receptive and responsive regions are often quite distinct from one another, and may be widely separated. What becomes of the stimulus between the two, and how is it transmitted? Remarkable experiments during the last ten years have given the answers to these questions. There is Ricca's work on the sensitive plant, *Mimosa*. The phenomena of transmission of stimuli in this plant are as striking as they are well known. The stimulus is propagated through its organs at velocities variously estimated at 10-20 mm. per second. This speed is fast among plants, but very slow when compared with the velocity of transmission of stimuli along animal nerves.

Two views were suggested to account for this propagation. The first referred the passage of stimuli to those excessively fine strands of protoplasm which, penetrating the walls of the living cells, place the protoplasts of adjacent cells in communication with one another. This view was a product of a period obsessed with

the physiological importance of these then recently discovered protoplasmic fibrillae, which, in all probability, have only a developmental significance. These fibrillae composed of living matter were supposed to convey stimuli just as the living processes of the nerve cells do in the animal body. The view was soon rendered untenable when it was shown that stimuli are effectively transmitted even after the protoplasm of the cells of the transmitting organs was killed by the application of heat. To meet this new growth of knowledge Haberlandt developed his theory, that the stimuli are transmitted in *Mimosa* in the form of a pulse in the water filling certain elongated tubular cells situated in the bast of the bundles. At the best this was an unsatisfactory theory.

In 1914, Ricca gave the *coup de grace* to the pulse theory. He showed that the stimulus is transmitted through a strand of *Mimosa* wood from which all the bast, including the tubes of supposed transmitting function had been removed from a considerable length.

Almost at the same time as Ricca was disposing of the older views regarding the transmission of stimuli in *Mimosa*, Boysen-Jensen was carrying out experiments on the phototropic reactions of seedlings, which were bound to have a profound effect on the received views regarding the propagation of stimuli.

When the tip of a grass seedling is illuminated one side a stimulus is transmitted from the receptive region downwards in the seedling and evokes a curvature in the shaded part. Boysen-Jensen found that this stimulus was transmitted downwards even when the protoplasmic continuity of the cells of the receptive apex with those of the responsive region was severed by complete section.

From this experiment and similar experiments by Stark, Snow and others it is quite evident that protoplasmic continuity is not requisite for the transmission of stimuli in the higher plants.

There is great probability that in these plants, as in *Mimosa*, the transmission of stimuli is effected by the transport in the transpiration-stream of a substance derived from the receptive cells, and conveyed by this means in the wood of the vascular bundles to the responsive region. Response is probably evoked by alterations in permeability.—Abstract from article by H. H. Dixon, F. R. S., in *Nature*, December 1, 1923.



Measuring a wire-glass window for distortion, after one hour's exposure to intense heat

IN the modern American methods of building construction, the column plays a most important part. Many structures are so designed that the walls carry little or no weight, but on the contrary constitute loads which must themselves be supported. But even in those cases where exterior walls support the outer ends of girders, these same girders are immediately carried by something else. In short, the tendency is to provide columns both for use in the interior parts of buildings and also for use in the regions where the walls are located.

The steel column is one form. It may rest upon a general foundation or upon a special pier of its own. It may extend upward to the top of the building, and at every floor may partially support one or several girders. Sometimes columns are supported by heavy girders, especially where some unusual element has to be cared for in the design. In the construction of the great Woolworth Building in New York City, certain piers were already sunk, when the site was enlarged and a relocation of columns became necessary. And so it came about that some columns rest not directly upon piers but upon girder construction connecting piers. In the Bankers Trust Company building and also in the Aeolian Building, both tall structures in the same city, one or more large rooms were desired where certain columns would be eliminated and a clear space provided. As these rooms were to be at low levels, it became necessary that overhead girders should supply foundation support for columns running all the way to the top of the building or up to a high level.

The cast iron column has ordinarily a more modest function than the more considerable steel columns, in that it will usually be a short affair. Reinforced concrete is another type of modern column. In this, the compressive load is carried by the concrete, and buckling and the like are prevented largely by the steel reinforcement. There is, however, still another type of column which consists of steel-work designed to carry the load or the most of it, but which is enveloped in concrete or some other fire-resistant material. Wooden columns are also in use. In fact, it is hard to drive wood from construction work, because of the fire resistance it presents to many destructive activities when it is properly installed.

Concrete is resistant to fire and to water. This combination seems a good one when we contemplate the hazards of fire. Steel is also good, but unfortunately it is liable to soften and bend under the influence of heat. We might raise the question, What will be the behavior of a given column when subjected to the heat of a conflagration and to the attack of water from fire hose when the column itself is heated? Questions such as this may seem very academic to the general public. But they are not so to those who, like the fire insurance companies, contract to make good the damage caused by fire. These people want to know, and in fact they need to know.

So, a few years ago, certain people having business reasons as an incentive and the U. S. Bureau of Standards co-operated in an effort to find out the facts, or a part of them. A series of tests was made, one hundred and six in all, which were directed towards the ascertainment of the behavior of columns exposed to fire while under a load of the kind imposed when they

Studying Fire Risks from Sample Fires

How the Behavior of Columns and Beams Under Exposure to Conflagrations Is Determined in the Laboratory

By J. F. Springer

are suitably installed in buildings. The columns were uniformly 12-23 feet in effective length and were designed to carry a load of 100,000 pounds. Some of the columns were steel, some cast iron, some steel pipe filled with concrete, some reinforced concrete and some wooden. In respect to length and load capacity, these 106 columns were representative units used in interior construction. Some of the columns were more or less protected by concrete, plaster and the like.

In order to imitate the conditions of a fire, the columns were tested in a gas furnace while under load. It may be seen from this combination of heat and load that the tests reproduced important conditions that would exist in an accidental fire or conflagration. Indeed, some of the columns were subjected to the

In a notable fire which occurred early in 1922, a spectacular view of the collapse of a building was presented. The Atlantic Building, in Chicago, was seen to lose portions of the outside wall. Now a portion would fall from one of the stories, now a portion from another story. The steel columns sagged and at last the remainder of the structure fell in a heap before the eyes of the onlookers. The insurance companies want something a good deal better than this. They apparently want the builders to put up structures having a good deal more of resistive power.

In one of the illustrations is shown a testing installation capable of producing the heating effects of a conflagration plus the compressive effects of a heavy building. The furnace door is open. In the compartment may be placed the column to be tested. Above is a hydraulic ram capable of exerting a downward thrust equivalent to the weight of 250 tons. Many thousands of dollars were expended on this equipment. In connection with it, instruments may be used for determining with precision the load actually sustained by the test column; for ascertaining the temperature inside the column; and for measuring the amount of sag, bend and shortening.

While the column is exposed to heat and pressure, a representative fire stream of cold water may be turned upon it and the effects noted.

It will be recalled that timber columns, while better than steel or cast iron, all being unprotected, did not show up so well in comparison with other kinds of columns. The lumber people became concerned over the poor showing of wood in such cases. It seems that for what is termed "mill construction" timber columns of high class had been enjoying a good reputation. Certain sample columns were expected, in the test, to sustain for one hour a standard load while surrounded by a fire whose temperature was being advanced at a standard rate. They did not stand the test for the expected period. They failed in half the time. Experiments were conducted for the purpose of finding out what was responsible. The wooden columns were observed to fail at the ends—not in the intermediate portion. At the end, the material appeared to suffer first a slow crushing, then a rapid one. There was perhaps

(Continued on page 438)

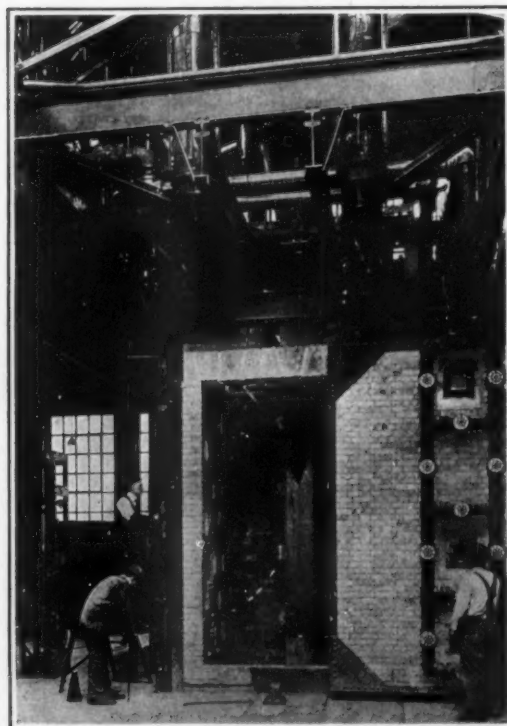


The wall carrying this frame is movable. It has just been subjected to intense heat; after which it has been moved to its present position and a stream of water turned upon it, in imitation of the sequence of exposure at a real fire.

Testing the fire resistance of a metal window frame

Impact of a stream of water while they were under load and in a heated condition. We have here the principal conditions existent in a fire after the lapse of a little time.

Those who constructed the building may have been satisfied with columns that carried their loads and would continue to carry them under the ordinary conditions of life. The insurance companies seem to want something more. Apparently, they want columns that will stand up and do their duty in spite of fire and water. An unprotected steel column may be economically built to sustain the proper load under usual conditions, but the tests show that when such a column is subjected to the hazards of fire, exclusive of water, it will probably fail in twenty minutes. Steel with all its strength and other admirable qualities seems to be, when used alone, one of the most inadequate of modern construction materials. Cast iron unprotected is better and a good deal better, since it can be counted upon for 35 minutes. The unprotected wooden column proved somewhat better yet, since it held out for 40 minutes. This seems surprising, no doubt, to most of my readers. Wood is a very good construction material and is, when used where it is continually submerged, almost indestructible. This has been understood to some extent by contractors having much experience with wooden piles. When wood suffers, it is usually some organic enemy that is at work. The star performers, however, in the fire tests were columns constructed of reinforced concrete and columns having a 4-inch protective envelope of concrete. These withstood the fire for eight hours.



Furnace with hydraulic ram above, in which structural units may be subjected to great heat and extreme pressure combined, as they are in the lower stories of a burning building

Torpedo Attack by Airplane

WHEN it was suggested several years ago that torpedoes could be launched from airplanes, the idea was received with doubt, if not with derision. It was urged that a torpedo weighing a ton or more was too heavy to be carried, and that to send it crashing into the sea from a height of many feet and at a speed of sixty to seventy miles an hour, would surely disorganize the delicate controlling mechanism, upon which the accuracy of the torpedo depends.

Despite these early misgivings, torpedoes of large size are now being carried by torpedo-planes and launched with an accuracy which establishes this new form of attack as a serious menace to the battleships and the larger cruisers.

The torpedo is held in stirrups below the body of the airplane, and at the desired moment is released by the pull of a lever. Before letting it go, the plane is levelled out, so as to insure that the torpedo will strike the water in the proper position. The releasing of the torpedo trips a lever that opens a throttle between the compressed air chamber and the turbine which drives the propellers.

The advantage of airplane over destroyer attack is found largely in the great speed and maneuvering ability of the airplane. A squadron of these, moving out to attack, would approach at high elevation; swoop down to within the chosen firing range, and when the planes were 15 to 20 feet above the water, they would drop their torpedoes and try to make the best of their way outside the range of the enemy fire. A direct attack in daylight would obviously be full of hazard, and it is probable that, as far as possible, torpedo-plane attacks will be made in the morning or evening dusk, on moonlight nights, or when the enemy is covered with a shallow and low-lying fog, above which the planes would operate. In such fogs, the plane has the advantage over the ship, that the visibility is better from above than from below, and under conditions where the anti-aircraft gunner cannot see the plane it is possible for the pilot to see the broad outline of the ship. While these conditions are favorable to the bomber, it is not likely that the torpedo plane will be able to do much in foggy or misty weather—this for the reason that the plane, during its approach, must get a reliable bearing on the ship before dropping its torpedo.

Both the British and our own Navies have carried out extensive practice in this comparatively new field of warfare. Excellent results have been secured by both navies, and much attention is being given to the question of the tactics of torpedo-plane attack.

Weather Bureau Record

FURNISHING of official weather data in admiralty proceedings is one of the important phases of the marine meteorological work of the Weather Bureau. The records of the bureau form practically the only source of such information. In some cases applicants for information will tell the bureau what they are trying to prove; in others this is not known. For the most part inquiries relate to storms and resulting damage to cargo or delay in shipment. A few are in regard to missing ships.

Ferry Boats with Turbo-Electric Drive

THE wide range of speed control which is such a marked feature of the turbo-electric drive assured its extended application in Marine practice, once it had been fully developed. One of the earliest and most notable installations was that made in the collier "Jupiter" of the United States Navy in 1912. This vessel and her sister the "Neptune" were both about 20,000-tons displacement, and were designed to be driven at 15 knots by turbines of 7000 horsepower. The "Neptune" was provided with a mechanical reduction gear between the turbine and pro-



Splash of the torpedo as it is dropped from torpedo plane

PELLER shaft, and in the "Jupiter" was installed the new electric system of reduction. It was this comparison and the success obtained with the "Jupiter" which led to the wide adoption of the turbo-electric drive in our Navy, all of our latest battleships being equipped with this system. Then followed its introduction into the merchant service, and of late years it has found increasing favor among yachtsmen and especially as an auxiliary drive for two and three-masted schooners.

And now comes a further application in the equipment of two new ferry boats, the "Hayward" and the "San Leandro," which are operating on the ferry-boat service across San Francisco Bay between San Fran-

cisco and Oakland. It had been apparent to the Board of Directors, that during the hours of peak load travel, the capacity of the existing ferry boats, which are among the largest of their kind in the world, had been reached and the necessity for more and larger ferry boats was realized. After an exhaustive study of the various types of propelling machinery, it was decided that the turbo-electric system was the most appropriate for this very exacting service. The new type of vessel, which we herewith illustrate, was designed by Mr. John B. Matthews, Naval Architect of San Francisco, assisted in matters pertaining to the selection of machinery, its installation, and so forth, by Captain J. E. Dor-

ring. The boats, which are built of steel are 240 feet in length, 42 feet in molded breadth, 62 feet 6 inches in breadth over the guards, and they have a molded depth of 19 feet 6 inches. The hulls are designed to insure absolute stability and great steadiness in the somewhat rough weather which is at times encountered on San Francisco Bay, and the weight of the framing and plating is somewhat in excess of that usually required by the American Bureau of Shipping. There are seven water-tight transverse bulkheads, so spaced that any one compartment may be completely flooded without endangering the safety of the vessel. The contract speed of the boats was 13 knots, and the main propelling machinery, built by the General Electric Company, consists of one turbo-generating set of the impulse, marine, condensing type, with a normal rating of 1000 kilowatts, 500 volt direct current, with one 75 kilowatt direct-connected, 115-volt exciter.

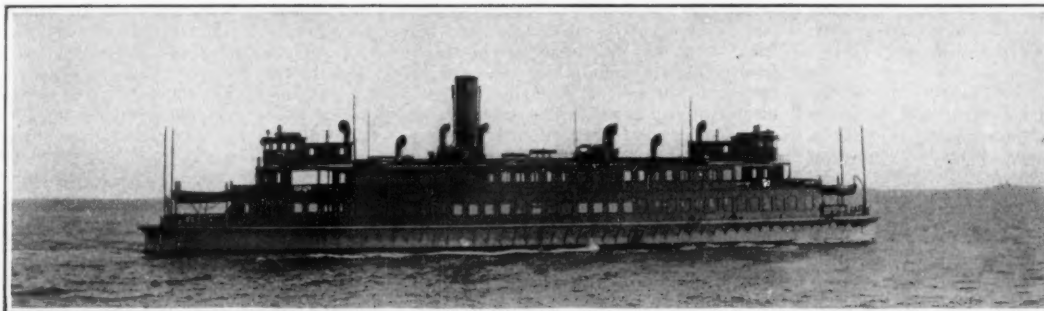
The turbines operate on 210 pounds steam throttle pressure with 50 degrees superheat, and a vacuum of 28½ on a 30-inch barometer reading. Steam is supplied by two Babcock & Wilcox boilers, carrying a steam pressure of 225 pounds a square inch. They are fitted with super-heaters capable of furnishing steam at 65 degrees Fahrenheit above normal. The boilers, which are of the oil-burning type, are fitted with Coen type burners under natural draft.

The vessel is fitted with two General Electric motors of double armature type, each designed for 1200 shaft horsepower at 125 revolutions a minute, and each is coupled through shafting to its own propeller, independently of the other. It will be understood of course that the ship carries a propeller at each end. The outfit is so arranged that either motor and its propeller may be operated to full speed requirements and only with a slight dependence upon the other motor. This is

operated by the Ward Leonard system of control which is operated from the engine room. This control is such, that when the motive power is furnishing all the driving power of the boat through the rear propeller, the speed of the forward motor can be regulated so that it will revolve only rapidly enough to relieve the drag or resistance of the forward or idling propeller, and vice versa when the direction of the vessel is reversed.

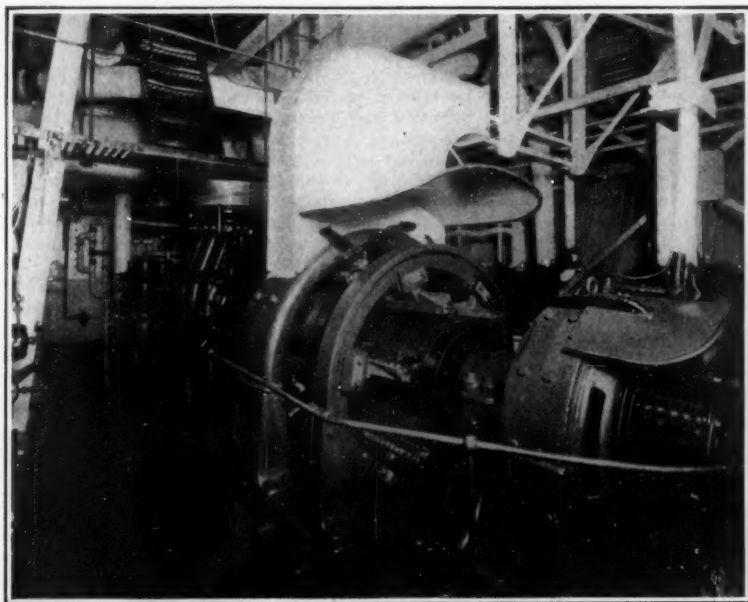
Now this arrangement of the driving machinery is a complete departure from previous ferry-boat practice. It eliminates the vibrations caused by the resistance of the forward propellers which occurs in ferries operated by reciprocating steam engines, which have a continuous shaft throughout the length of the vessel with propeller wheels at each end operating at the same speed. The total passenger carrying capacity of each of the new boats is 3000 with seating capacity for 2000.

A severe test of the seaworthiness of these boats was obtained on the trip north of the "Hayward" on the Pacific Ocean from San Pedro to San Francisco Bay, when the vessel was navigated through heavy rain squalls in a very rough sea. The boat showed her stability by righting herself in the heavy seas in a very easy and prompt manner. In the tests for acceptance, the "Hayward" reached a speed of 15 knots or 17.29 land miles per hour; and during the special tests to determine the maneuvering qualities of the boat, it was found that when the motor control was thrown from full speed ahead to full speed astern, the motors actually started to revolve in the reverse direction in 2 2/5 seconds, and that the time required to bring the vessel to a dead stop under normal conditions was only 36 seconds. Tests showed that the idling motors automatically took 31 per cent of the load in starting and stopping, and that this gradually diminishes to merely a friction load as the boat comes up to speed.



This is one of two turbo-electric-driven ferry boats, recently built for the Oakland-San Francisco service. Length, 240 feet. Speed, 13-15 knots

ring. The boats, which are built of steel are 240 feet in length, 42 feet in molded breadth, 62 feet 6 inches in breadth over the guards, and they have a molded depth of 19 feet 6 inches. The hulls are designed to insure absolute stability and great steadiness in the somewhat rough weather which is at times encountered on San Francisco Bay, and the weight of the framing and plating is somewhat in excess of that usually required by the American Bureau of Shipping. There are seven water-tight transverse bulkheads, so spaced that any one compartment may be completely flooded without endangering the safety of the vessel. The contract speed of the boats was 13 knots, and the main propelling machinery, built by the General Electric Company, consists of one turbo-generating set of the impulse, marine, condensing type, with a normal rating of 1000 kilowatts, 500 volt direct current, with one 75 kilowatt direct-connected, 115-volt exciter.



The generator and exciter of the turbo-electric drive

It takes a million years for a lump of coal to form, but only a few minutes for it to be burnt up and totally destroyed. To the average man the sole use for coal is to heat his furnace so that he can keep warm in cold weather. In times of stress, as during the past winter, the fact that coal is very necessary for this purpose is brought home to him emphatically by simply having to do without it for a short time. Of course, it may be known that coal has other uses than the mere production of heat and power, but it is hardly appreciated by the average citizen that a great many of the comforts and necessities of life, without which he could hardly conceive of living, are available to him just because Nature, millions of years in the past, started a process of decomposition of vegetable matter under suitable conditions of pressure and temperature, which resulted in the formation of the product that we call coal.

When the shovelful of coal is thrown on the fire, there is little thought that enormous potentialities are being consumed in smoke. If the flames could reveal their story, there would be unfolded a picture, far more wondrous than the most impossible fairy tale. For in them there would be seen the hospital and sick-room with the doctor or nurse administering a life-saving drug made from coal; the battlefield with shot and shell bursting all around, exploded by products derived from the same source; the fertile fields, sown with grain, corn and other life-sustaining plants, bearing abundant crops of foodstuffs, fertilized and rendered productive with products derived from coal; the fair lady's boudoir with the fine cosmetics and exquisite scent bottles, owing their fragrant odors to perfumes made synthetically from products obtained from coal; the counter in the department store, strewn with fabrics colored in most variegated and splendid colors, the Tyrian purple once the color par excellence of royalty and the mighty of the earth, now rendered available to everyone no matter what his station in life may be, through the synthetic dye, even more beautiful than the natural product, that dye manufactured from coal derivatives. This picture would cover practically every field of human endeavor, every daily necessity or luxury, for coal, coal tar, ammonia, the hundreds of derivatives that are produced from the parent substance, coal, enter into the manufacture and the production of most of the materials and articles, met with in everyday life. The burning of a lump of coal in the furnace or stove represents not merely a consumption of carbon to produce heat or power, but the destruction of an immensity of possibilities, such as is not equalled by any other single action of common every day occurrence.

One of the principal uses of coal is in the manufacture of gas. There are different kinds of gas, ac-

Coal and Coal Tar

cording to the use to which it is put. Thus, the ordinary gas, that we burn in our gas ranges or perhaps use for lighting purposes as well, is coal gas or illuminating gas. Coal gas is made by baking the coal in specially built ovens. The coal is not burnt, as many people suppose, but it is baked or destructively distilled. Water gas is another gas which is used in the household, either as such or in admixture with coal gas. Water gas is made by blowing steam through a hot bed of coke, heated to incandescence. This gas, while suitable for heating purposes, must be enriched with the gaseous products obtained by dropping gas oil, a petroleum product, on heated plates, so as to make it usable for illuminating purposes. Another gas, made from coal or coke, is known as producer gas, which is used exclusively in the factory for manufacturing purposes.

The gas industry, that is the coal gas industry, started in England. In 1792 a man named Murdock first employed coal gas lighting purposes on a large scale. From then on the progress of the industry was rapid, until today there are over 1500 gas companies in this country alone. Now, in making gas from coal, it was soon found that there were many substances mixed with the gas which were decidedly deleterious to its use in the household. These substances had to be removed from the coal gas, before the latter could be used safely and conveniently for cooking and lighting purposes. The task of scrubbing and absorbing these impurities, ammonia, sulfur, tar, cyanogen was first considered a troublesome and costly affair, until it was found that the value of these products and of the various manufactured substances that could be obtained from them was far in excess of the value of the gas itself. Thus ammonia was converted into the valuable fertilizer sulfate of ammonia, or into the explosive nitrate of ammonia. The sulfur and cyanogen were changed into various iron derivatives, which are useful as pigments for paint and varnish manufacture or in making other pigments.

Of all these substances, the coal tar looked perhaps the least promising but contained the greatest potentialities of all. For a long time the tar was looked upon as a good deal of a nuisance and there did not appear to be any way of using it. All sorts of efforts were made to get rid of the messy substance and surreptitious dumping was resorted to in certain cases. The continuous production of this substance, however, led to considerable investigation to determine its exact composition and the possibility of obtaining useful products from it. It was soon found that it contained quite a variety of constituents and that it was in reality an extraordinarily complex substance.

While this development was going on in the gas in-

dustry and uses were being gradually discovered for gas works tar, another large growth took place in the steel industry and in the manufacture of coke, which are essential correlated industries. Coke is the residue that is left when coal is destructively distilled. The first process of making coke for the blast furnace was to burn the coal in covered piles, avoiding the presence of an excess of air. The same valuable by-products that are obtained in gas manufacture were allowed to go to waste, until the by-product coke oven was developed. The use of this oven allowed the recovery of the by-products, particularly coal tar, which is derived from this source in greatest amount at the present time. To the ordinary person tar is tar, but there really is a great difference between the various kinds of tar recovered in the various processes of distilling coal. Furthermore each and every tar has its special applications.

There are very few uses for the crude coal tar. It is mixed with creosote oil and employed for the impregnation of wood paving blocks to waterproof and preserve the same. Besides its use as a fuel in the plants where it is produced, this is practically the only important, commercial use for crude coal tar, although the purified and dehydrated crude coal tar is employed for the impregnation of felts in the manufacture of roofings.

But, when the constituents of the coal tar are separated from it, then there are obtained substances which are perhaps among the most important chemicals used at the present time and which form the basis of the manufacture of a greater variety of products than any other raw materials known to the industrial world. The coal tar is distilled, yielding the following products: light oil, carbolic oil, dead or creosote oil, anthracene oil and the residue pitch. By further distillation of these products there are obtained benzene, toluene, xylene, pure naphthalene, pure anthracene, pure phenol and cresol. These substances form the basis of the synthetic dye industry and are also utilized in the manufacture of synthetic perfumes and drugs. The drawing on page 373 will give an idea of their scope and industrial importance.

Benzene is a clear colorless liquid, possessing a distinct odor and entirely different from the benzine distilled from petroleum. It is used as a solvent for paints and varnishes, in the dry cleaning of clothes, for extracting fats and greases, in making rubber cements and as a fuel for automobile engines. From benzene it is possible to synthesize aniline, which is the basis of a large class of synthetic colors, known as aniline dyes. Synthetic phenol is made from benzene, and the former may then be converted to the military explosive, picric acid and various other substances used in building up the most complex dyes, drugs and perfumes.

Toluene is the basis of the explosive TNT, which was
(Continued on page 435)

Color in Nature

We live in a world of color. Not only is color a natural characteristic of all forms of nature, but Man endeavors to surround himself with even more color by dyeing his textiles, painting his houses and structures and in fact coloring almost everything that he fabricates not excepting his own person. He finds a principal use for color as a decoration, although during the past war, emulating the example of nature, he employed colors in camouflaging his ships on the high seas, his structures and gun carriages on land to protect them by rendering them less visible to the enemy.

Color in nature has its utilitarian purpose as well as its decorative. The coloring on animals affords them protection by causing them to blend with their surroundings so that their natural enemies and Man cannot easily find them. The green coloring matter in leaves is a chemical reagent and converts the carbonic acid gas taken into the plant from the air into starch and cellulose and the complex substances found in plants. The beautiful coloration of flowers serves to attract to them the pollen-bearing insects. The yellow stripes of color on the skin of the tiger, the sandy skin of the lion, the spots of the leopard, the stripes of the zebra, the white fur of the polar animals, the dull coloration on fishes, the brown color of insects are all examples of protective coloration. On the other hand the brilliant colors of the feathers of birds are for decorative effect only and play a part in sexual attraction.

The average person is apt to think that all the color effects that are seen in nature are produced by the presence of certain substances, dyes or the like, which possess distinctive colors. This is true to a certain extent as it has been found that the colors in flowers

are due to the presence of substances known as anthocyan pigments. But the dispersion of light in striking scales and other agencies such as minute air cells is sometimes the cause of the colors that are seen in birds' feathers. Thus, the feathers of the blue bird, the king-fisher and other birds are colored blue due to the dispersion of the light striking the minute air cells in the horny structure of the feathers. So far no blue pigment has been extracted from these feathers.

Similarly the brilliant iridescent colors in the tail feathers of the peacock or in the throat feathers of the humming bird are not due to the presence of any pigments in the feathers, but to the dispersion of light by the thin laminae in the barboles of the feathers. This conclusion is substantiated by the fact that when the feather of the peacock is viewed in transmitted light, it shows none of the color effects that are seen when the light is reflected and refracted from the surface of the same, and furthermore different color effects can be seen by having the light strike the feathers at different angles. On the other hand certain bird feathers also possess color pigments which either determine the color of the feathers alone or serve as a background for the color effects produced by the action of light.

The blue of the sky and the blue of the human and animal eye are also caused by the action of light. In the first place the dust in the air causes the dispersion of the light and its decomposition into its component parts, while in the case of the eye it is due to the presence of finely divided particles suspended in the liquid medium of the iris. Green, brown and black eyes take their color from a combination of this light dispersion effect and the presence of actual color in the eye.

Flowers and fruits owe their color principally to the presence of pigments in them, although in the case of the lily, the white color is due to the structural make-up of the petals. Of course the number of different coloring matters in nature is very great, but probably the most interesting and most important of these substances are the anthocyanins, which produce some of the most beautiful effects. It has been found that the color of the flower or the fruit depends not only on the presence of some of this series of coloring matters but also on the presence of certain other substances such as tannin or iron salts. Then again the color will vary according to whether the anthocyan is present in the fruit or flower either in the free or combined state.

A few examples are cited to show how the color effects vary in natural products with the presence of different anthocyanins. Thus cyanin is responsible for the coloring of the cornflower although it is present only in the proportion of 0.7 per cent. But when it occurs in as high a proportion as 14 per cent it produces a dark red coloration as in the garden variety of this flower. Violanin is the coloring matter in the violet pansy in which about 33 per cent of the substance is present. Asterin and chrysanthem in are the coloring agents which we find in the aster and the chrysanthemum respectively.

It is strange that these coloring matters which give such lasting colors in flowers produce only fugitive results when used on textile fabrics. They are all complex substances and one of the real marvels of nature is the ease with which the plant builds up these coloring matters. The chemist succeeds in synthesizing them with great difficulty only, and by methods so complex that it is obvious that we are not even on the road toward learning how the plants do it.



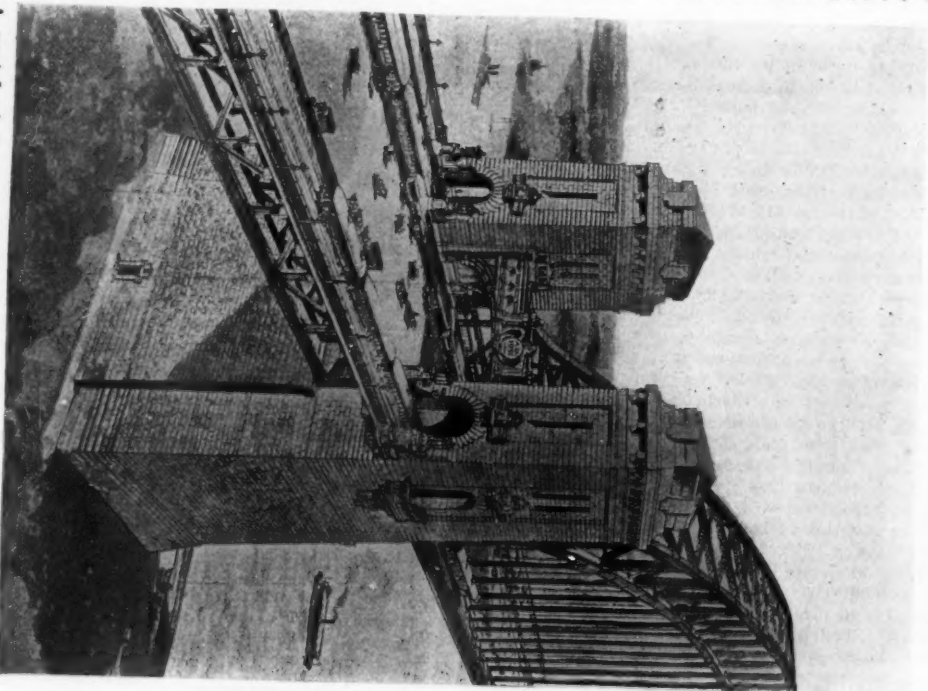
No; this is not Hell Gate bridge. It is the accepted design, modelled on that famous structure, for Sydney Harbor bridge, Australia. Its length, 1650 feet, will render it the largest arch in existence

A MONG the natural harbors of the world, that at Sydney, New South Wales, Australia, holds a commanding position. Landlocked, the harbor broadens out among the surrounding hills and represents, not only abundant anchorage but a long stretch of shore line suitable for docks and terminal facilities. Sydney harbor, however, labors under the same disadvantage as the port of New York, to the extent in half. In this respect, the channel between Dawes Point and Milsons Point is as much an obstruction to free intercourse between various points of Sydney as the Hudson and East Rivers are between Manhattan, Long Island and Jersey City. Hitherto, transportation at Sydney has had to content itself with the lighter and the passenger ferry boat, and in Sydney as in New York the problem of rapid transit across the waterway for many years has been the subject of much deliberation and planning.

In the *Scientific American* of September, 1922, we published a drawing showing the proposed plans for a large cantilever bridge, designed by John I. C. Bradfield, the chief engineer, for crossing the channel at Sydney. In the interim, further study of the problem has been made, and the chief engineer made an extended tour in the United States, England and the continent of Europe to study the existing long-span bridges of those countries. Upon his return, he enlarged the specifications for the Sydney bridge to include plans for bridging the channel with the great arch bridge which forms the subject of our illustrations. Tenders were asked from the engineers of the world, and as a result no less than twenty-two separate plans were turned in by six different firms. The designs were of a very wide variety of types, and included six for an arch bridge, two for a cantilever arch, eight for a cantilever, five for a suspension and one English firm of Dorman Long & Company, which in addition to its manufacturing plants in England, for many years has owned extensive works in Australia. The bids were made upon the design drawn up by Mr. Bradfield as shown in the accompanying illustration. The total cost is about twenty-one million dollars, and the total weight of steel in the bridge will be 50,626 tons.

Among the bids was that of the McClintic Marshall Products Company of Pittsburgh, who put in one bid for an arch bridge, three designs the suspension bridge designed by Mr. Gustav Lindenthal was the lightest, and called for a total of 43,029 tons of steel.

It should be mentioned that the terms of the specifications, as laid down by the New South Wales authorities, called for the construction of a part of the steel work in Australia, the balance, including the heavier rolled members, to be imported from abroad. If so desired, imported steel, coupled with the high cost of American labor and the cost of transportation, placed a heavy handicap upon any United States competitor. The successful bidder, however, is in the advantageous position of possessing long-established works in Australia, which they intend to enlarge, building new mills, which will enable



A portal of the great arch bridge across Sydney Harbor Channel, Australia

them to fabricate the bridge work in Australia and near the site. The new bridge is favored as to its site by the fact that, on each shore, good rock, suitable to take the heavy thrust of the abutments, is found not far below the surface. Sydney Harbor and Sydney are renowned for their picturesque beauty, and hence the question of bridges carried considerable weight in determining the type of bridge. It was felt that an arch bridge, better than any other type, would harmonize with the surroundings; both because of its artistic and its monumental effects; a decision with which we are in hearty agreement.

On each shore the bridge will terminate in a massive tower, faced with cut granite, which will be of solid construction up to the floor of the bridge and above the floor will consist of two individual towers. The length of the bridge between the end piers will be 1650 feet or 50 feet longer than the Brooklyn bridge in New York. The width of the floor will be about 100 feet. The great arch will be 180 feet deep at each portal and 60 feet deep at the crown of the arch. The clearance above water will be 170 feet, and the crown of the arch at its center will be about 400 feet above the water.

The floor system will be built up of the usual floor beams and stringers, covered with steel buckles, upon which will be a layer of concrete finished off with a water-tight asphalt surface. Provision will be made for four railroad tracks, two for the main line service and two for trolley service. There will also be a center roadway 57 feet wide, and two 10-foot paths for foot passengers. The steam railroad tracks upon which the design will be based, are designed to carry a load of two 150-ton locomotives, each 65 feet long, followed by the usual train load, and the trolley-truck load will consist of the heaviest modern electric cars.

Now to American eyes and especially to New Yorkers, this design for the Sydney bridge will look strangely familiar. As a matter of fact, the design is based upon Mr. Lindenthal's famous Hell Gate bridge, and so far as the skeleton outline is concerned, it is practically a 50 per cent enlargement of that design. The similarity is observable even to the reversed curve of the upper chord of the bridge at the portal, which was used for the first time in the Hell Gate bridge, and was put in to obtain the necessary clearance for the traffic. Also, the system of triangulation in the arch is the same, and Mr. Bradfield chose also an odd number of panels, with countersign. If imitation is the sincerest flattery, as the old adage says, the greatest steel arch in the world, its engineer should have come to America for his inspiration, and this in spite of the fact that nowhere in the specifications has the slightest credit been given to the designer of the Hell Gate bridge.

It is of interest to note that for its size, the Hell Gate arch is the heaviest in existence, and will continue to be so when the Sydney bridge has been completed. The live load of the latter is 12,000 pounds per foot, whereas the Hell Gate live load is 24,000 pounds; this being due to the heavy test loading for Hell Gate of four continuous lines of the heaviest steam locomotives on each of the four trucks.

Fighting the Bed Bug

How a Bitter and Dangerous Enemy of Mankind Is Being Routed With Such Weapons as Propaganda and Poison Gas

By James H. Collins

IN HIMSELF, the rat has no commercial value. Man has seldom been forced to eat him, and his pelt is worth little or nothing. Therefore, man has lived tolerantly with the rat for ages, reducing the rodent population from time to time when damage to and destruction to his goods grew beyond the point of tolerance. But the fight was never carried to extermination—in fact, until this generation, man has not had scientific means for exterminating the rat.

This will undoubtedly strike you as a novel way of looking at Brother Rat. It is the viewpoint of an expert who has made a life study of rodents and other vermin, Mr. N. N. Sameth, executive head of a large New York exterminating organization, who attacks man's pests with the weapons of the bacteriologist, chemist, biologist and entomologist, and who has lectured on the subject to the public health service classes at Bellevue Hospital, and other institutions.

Today, a new weapon is being turned against the rat—public opinion. The discovery that he transmits through his fleas such terrible diseases as bubonic plague and typhus, has made an appeal to the man in the street, enlisting him in a world-war of extermina-



Hand apparatus for exterminating insect pests in small rooms

tion. This war has only reached the skirmish stage. Even in a city like New York, where the health authorities systematically trap and examine thousands of rats yearly to guard against plague, the rat population is on the increase, and newspaper accounts of persons being attacked and bitten by rats in their homes—particularly children—are becoming more frequent. Mr. Sameth says that they will be even commoner news until it is made unlawful to harbor rats, because Manhattan Island, bounded almost wholly by water, prevents emigration of increased rodent population, and where one property owner takes steps to rid his premises of rodents, ten others harbor them.

Just as scientists mobilized public opinion by "getting something" on the rat, now they are working to "get something" on a more widely annoying pest—the bed bug.

Tell the man in the street Pottos has demonstrated that the bed bug's bite transmits the parasite of the tropical disease known as Kala-azar; that Nuttall succeeded in transmitting germs through the bite of bed bugs from one mouse to another; that it is supposed bed bugs spread the germ of Obermeyer's relapsing fever; that Pasteur and Metchnikoff were probably the first to bring the bed bug under suspicion as a disease carrier—

"I should worry!" thinks the man in the street in New York, South Bend or Gopher Prairie. "Probably" and far-off tropical maladies that he never heard of do not give him the necessary thrill of fear. But if this pest transmits something right around the corner, like tuberculosis, and it can be proved, public opinion will

condemn the bed bug and demand its extermination.

"Dutton has shown by experiments that the bed bug may spread typhoid fever," says Mr. Sameth. "Bugs were infected by feeding on the blood of a person in the acute stage of this fever, and the bacilli were retained by the bug in a virulent condition for at least twenty-four hours. There is evidence that the bug assisted in the spread of the influenza epidemic, particularly in lodging houses, boarding houses, hotels and other places where the same beds are occupied by different persons in succession."

Until the war, bed bugs were a reproach to nice people. When they appeared, nice people got rid of them by greater cleanliness. But the war crowded humanity together everywhere, and as people crowd, pests of every kind increase. Today, not even nice people escape the bed bug. He may turn up in the most carefully kept homes. His presence is not a reproach, but a danger signal.

The bed bug is a great traveler. Not content with a comfortable home in some cheap boarding house, he attaches himself to clothing and is carried to the locker room of an office, the cloak room of an hotel, the back seat of an automobile, the berth in a sleeping car. There he switches to some other person's clothing and invades an uninfected home. Maybe only one of him, and "he" is used correctly here, for in breeding sex doesn't matter at all in the travels of this pest. Both the female and male carry a supply of eggs ready to set up housekeeping and raise a family when they find suitable quarters. Six weeks is enough. Before the days of steam-heated apartments, incubation was checked during the winter, but now it goes on practically all year round.

Back in pre-historic days, the little brown parasite was presumably a wood-dweller and vegetarian. He had wings, of which remnants can be seen under the microscope. It is conjectured that when man came out of caves, after the last ice age, and began building log cabins, the insect was carried to the first houses with the logs. There he found a richer and more abundant kind of food than plant juices—human blood. He became lazy, lost his wings, and ultimately turned cannibal. He is still lazy, for once settled in walls and sleeping places, he will not travel far from home by his own exertions. But he does get carried about in many ways.

"He is introduced into clean homes in ways which are unsuspected," says Mr. Sameth. "Packages are brought from infected places or by people who may be carriers. Such packages are often dropped or opened on beds or couches. A party brings an unusual number of guests, coat racks and hooks are filled with their wraps, and the bed is used for the rest. Laundry packages, clothes brought home after pressing, mattresses sent to the renovator, books from circulating libraries, baggage brought into the home by members of the family who have been traveling, moving vans and warehouses in which furniture is carried or stored—these are channels through which the insect constantly travels and may find entrance. Servants visit their own homes in infected tenements, bringing the pest back with them. Clothing hung in offices, factory lockers and even checked in hotels, restaurants, clubs and theaters, is a common means of transportation. When his methods of traveling are known, a little care in receiving packages, hanging up outer clothing and not using beds as catchalls, is good prevention,



The Modern Pied Piper of Hamelin—bed bugs and all vermin are now exterminated with poison gas, applied by a masked operative

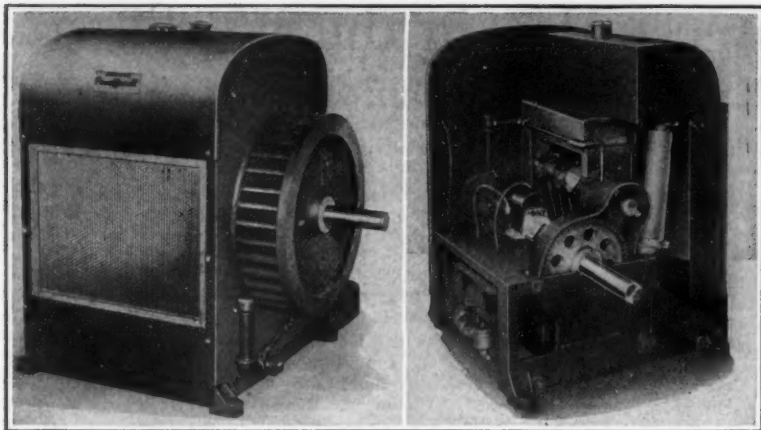
and will keep him out nine times in ten. But sooner or later, he is pretty certain to arrive."

The vitality of this insect is remarkable. Specimens hatched in the laboratory have survived several months without tasting food from birth to death, while others fed in the laboratory have lived from two months to a year. A solitary specimen brought into an empty apartment will rear a family and thrive, though people may not enter the room for months. If its principal food is lacking, it will drop down to a mouse or rat hole and feed, or suck blood from a cat, a dog, a bird. If these recourses are lacking, individual insects may die after several months' starvation, but the colony goes on a year or more. It was once thought that the insect could live on moisture from wood, or the dust found in walls and floors. This has never been demonstrated, but entomologists believe that the colony can support itself for a long period by cannibalism, the old eating the eggs or the young, and the young living on insects that die of old age. Although the insect stops feeding and breeding when the thermometer goes below 60 degrees Fahrenheit, he will live through long periods through temperatures lower than freezing. In fact, he is far more troublesome in northern than southern climates, for he cannot stand heat nearly as well as cold. When the thermometer goes above 100, he dies.

For years, this pest has been fought with soap and
(Continued on page 439)



Apparatus for generating and applying hydrocyanic gas in bed bug extermination. In New York it costs \$5 to \$10 a room, and requires about three hours



Clothed and unclothed views of the latest gasoline engine for stationary use

A Gasoline Engine That Is Different

BECAUSE of the similarity of most gasoline engines, it is refreshing once in a while to see a gasoline engine that is decidedly different. And that is no doubt the reason why the Denison engine, which is shown in the accompanying illustrations, attracted unusual attention and a deal of comment at the recent National Good Roads Show held in Chicago.

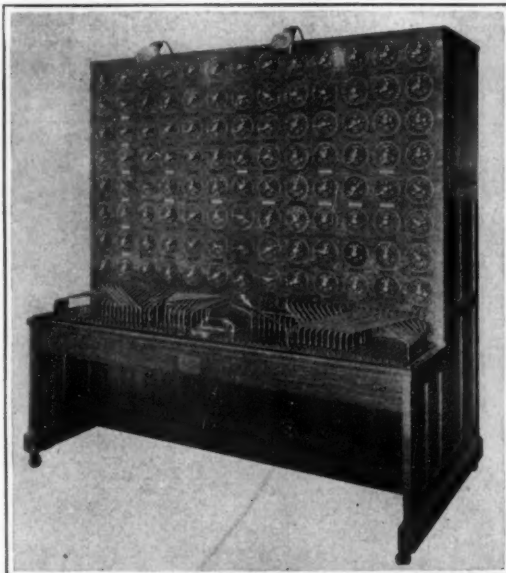
The Denison engine is an inverted, two-cylinder, four-cycle, water-cooled engine, entirely housed in a pressed steel casing. The cylinders, bearing standards and base are all included in one casting, which makes the unit quite rigid and with permanent and proper alignment of piston, crank shaft, and cam shaft. The crank shaft, cam shaft, magneto governor assembly and the connecting rods are located on top of the main base casting, so that adjustments can be quickly and easily made. The valve box, which includes the valves, intake and exhaust manifold, and the carbureter, can be quickly and easily removed by taking out six machine bolts.

Cooling water from the radiator upon entering the cylinder block, strikes the cylinder head, which is the hottest part of the unit, and rises as it is heated, producing rapid water circulation and uniform cooling. Air is drawn through the radiator by a fly-wheel type fan. The radiator is shrouded, so that the dust and dirt going through it with the air does not come in contact with any part of the working mechanism. The fuel tank is located at the top of the housing. The new engine is on its face not adapted to automotive use, but for stationary work of every description is claimed to possess many advantages over more familiar types.

Electric Light Extremes

THE smallest and the largest incandescent lamps in the world, one rated at about one-quarter candlepower and the other at about 100,000 candlepower, make an interesting display when shown side by side. The large lamp, with a bulb 12 inches in diameter and 18½ inches high, was developed primarily for motion-picture studio use. It is rated at 30,000 watts, or 1200 times larger than the average household lamp; and the electric current required to operate three of these lamps would be equivalent to the power used to operate the average street car.

The small lamp, known as



The machine that reproduces, in miniature, any short circuit of the high-tension transmission lines whose effects it is desired to study

combined light from 2400 electric lamps of the size commonly used in the home. The filament is made of tungsten wire one-tenth of an inch in diameter and 93 inches long, constructed into four coils. This wire, if drawn into filament wire of the size used in the 25-watt household lamps, would supply filaments for 55,000 such lamps. These lamps are classified as the Mazda C type, being gas filled, and

are lighted from a 120-volt, 250-ampere circuit. Consuming 30 kilowatts, the cost to operate such a lamp with current at 10 cents per kilowatt would be \$3 per hour.

Foretelling the Effect of Short Circuits

WHEN the cord of an electric iron becomes worn the two separate wires which carry the current touch each other. The result is a puff of smoke, a smell of rubber and no more heat in the iron. The electrician tells you that a short circuit has taken place and burned the wires in two.

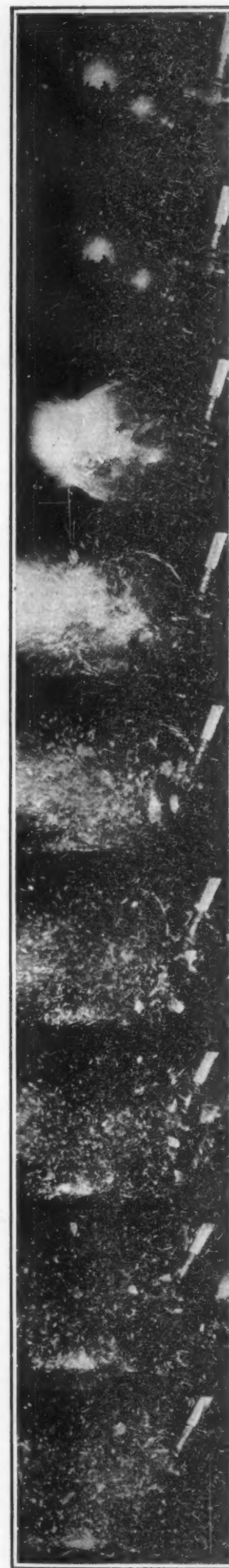
This is a miniature of what happens when a power cable of an electric system breaks and comes in contact with another cable on the ground. Provision must be made to keep the damage as small as possible and to do so the electrical engineer must know what will be the effect of a large quantity of electricity running wild at any given point of a power system. As the calculations which give the answer to this difficult problem are frequently very complicated, the General Electric engineers have devised a machine that tells in thirty seconds what would take that many hours to calculate by the slide rule and pencil method.

The machine weighs 3500 pounds and stands eight feet high. With its 104 adjusting dials it looks some-

thing like a combination of an overgrown radio outfit and telephone switchboard. In it are combined a great number of wires connected to what are known as variable resistance units which may be so joined that they will correspond to the network of cables of a great power system. Direct current is fed into this miniature power system at points where the great generators really would be in the actual system. The dials are manipulated to simulate the conditions which occur when any short circuit takes place such as caused by a cable falling across a street car line or the breaking of a main feeder cable. As each accident is brought about in miniature the effect of the runaway current is told instantly by the sensitive needle of an electric meter.

When the Hammer Landed

WHAT happened when a ten-inch vacuum globe of glass was struck with a heavy hammer is told by the strip of pictures at the right of the page. The time consumed in the actual breaking of the glass, as shown by the first five panels of the film, is estimated at 3/500 second. The experiment was filmed with two cameras, operating simultaneously, one at the standard speed of 16 panels per second, while the second, an ultra-speed camera, was apparently working well in excess of 500 exposures per second. The standard camera shows the globe intact in one exposure, and in the next frame it has disappeared completely, with the exception of a few minute fragments. The ultra-speed negative shows five stages in the breaking process, followed by four views of flying fragments. The first film actually shows the slight indentation made in the glass by the hammer head; the second indicates that the first actual fracture occurred, not at this point of contact, but on the far side. The third view confirms this, and shows that the breakage of the glass actually proceeds toward the point of impact, from the point of initial fracture. The fourth and fifth views merely complete the picture.



Rapid-motion analysis of the sequence of events in the breaking of a vacuum tube by a hammer blow



Extremes of the day in electric lamps

The Largest Map in the World

A Monster Model, in Relief, of the Entire State of California

By H. H. Dunn



Cutting up sponges to make the miniature forests and orchards on the world's largest map

MODELED of magnesite, showing all the natural as well as man-made features of an entire state, the largest map in the world, is being erected in the state-owned Ferry Building in San Francisco, by the combined efforts and funds of the 58 counties of California. The map, which is about two-thirds completed, is 600 feet long and 18 feet wide, literally a "working model" of the entire State of California, costing \$100,000. Its construction has required the constant work of J. T. Edwards, F. R. G. S., and 25 assistants rather more than a year, and it will be completed late in 1924. The cover painting for this issue shows a stage in the work on this giant map.

The map is in reality a huge model, but so fitted with interior and flood lights, all concealed, that one appears to be getting a perspective from an airplane or balloon of the whole state. First of all, the state was built up in relief, as it was before white men came. All the mountains and ranges were put in according to scale, all the rivers, bays, lakes and coast line modeled on data furnished by the United States Geodetic and Geological surveys and the various departments of the State government. Then the mountains were colored according to the reports of these surveys, existing volcanic craters were formed, and the one active cone, Mount Lassen, equipped with internal lighting so as to maintain the effect of fire within the crater.

Then the lowlands, running from the foothills down to the sea, were put in with the Coast and Geodetic Survey furnishing the information as to coast line, bays, islands, channels, and depths of water. Cliffs, marshes, and sandy beaches were reproduced all in exact colors along the shore. Forests of redwood, oak and pine were made from carved fragments of sponges, painted green of the varying natural shades and set up at the proper locations and correct elevations in the mountains and hills. Paved and unpaved roads, grades for railroads, and all the mountain trails were then carved out as trenches, and filled in with magnesite, white-surfaced for the paved roads, gray for the graveled roads, and graded up with sand for the railroad rights of way. Highways average about an inch in width, roads three-quarters of an inch, and railroads half an inch. Every mile of the 6000 of paved highways is shown in clear white finish, and no railroad is too small to be shown. Ties and rails were modeled and laid on the rights of way; tunnels were cut through the mountain walls wherever they exist, and trestles and bridges put in. Every flag station on the railroads is shown by a tiny building, just as clearly as the large stations in the cities. Mine shafts were bored

and small buildings set up about them to show the productive mines, and the oil fields are located, at the points on the big map where they belong, by miniature forests of tiny derricks.

The cattle, sheep and horse-raising industries are indicated as to area by groups of these animals each half an inch in length, while the sections in which deer, bear, mountain lion and other animals exist are shown by similar models of these animals. The grain section is shown by golden and brown sections of ripening grain; the deciduous fruit districts by green groves of cherries, peaches and apricots, and the citrus fruit range by similar groves bearing tiny golden balls indicative of oranges, grapefruit and lemons. No one of the trees is more than an inch in height, yet the effect is startlingly like that of looking at a huge photograph of a grove. These trees and other features are, of course, out of scale with the length and breadth of the map; but the answer to that is "perspective."

Steamers and barges are placed on the rivers at the proper points to indicate directions and limits of inland water traffic, with small boats and rafts further up to show the extent of shallow-draft boating. Irrigation systems and hydro-electric power plants were put in. Each city is indicated by a group of tiny buildings modeled after the structures in that city; wharves are shown in the ports; models of ships indicate the channels in each harbor, and the sea-traffic lanes into and

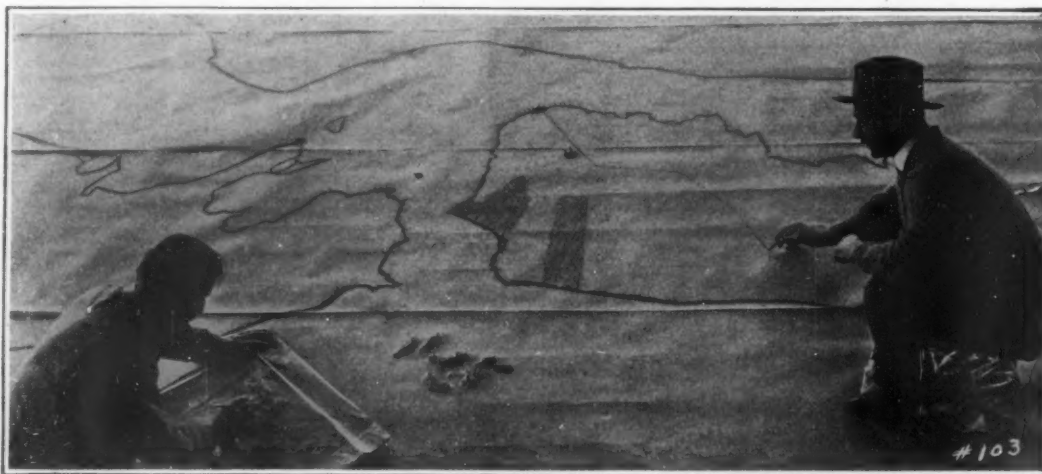
irrigation system is located. Every department of the State government and many of the departments of the national government contributed to this huge sculpture of the State.

The Rotary System of Oil-Well Drilling

ON December 11, Mr. L. R. McCollum presented to the Institution of Petroleum Technologists (British) an account of the rotary system of drilling, now of increasing importance throughout the principal oil-fields of the world. Broadly speaking, two systems of drilling are employed today—the cable-tool or percussion system, whereby the hole is literally pounded out by a cutting-bit alternately raised and lowered to produce a succession of "blows," and the rotary system, in which a rigid pipe-stem rotates a special type of cutting-bit, a mud-flush being pumped down under hydraulic pressure through the drill-pipe. This flush serves to lubricate the process of drilling, drive the cuttings up out of the hole, and at the same time "mud up" the formations to prevent their caving; hence, the special adaptability of the system to unconsolidated and caving sands or silts such as are commonly met with in the Gulf Coast fields of Texas and Louisiana, where the system was perfected in the first instance. The cable-tool system is better suited to harder rocks. The chief advantage of the rotary system is the rapidity with which a well can be drilled, 450 feet per day

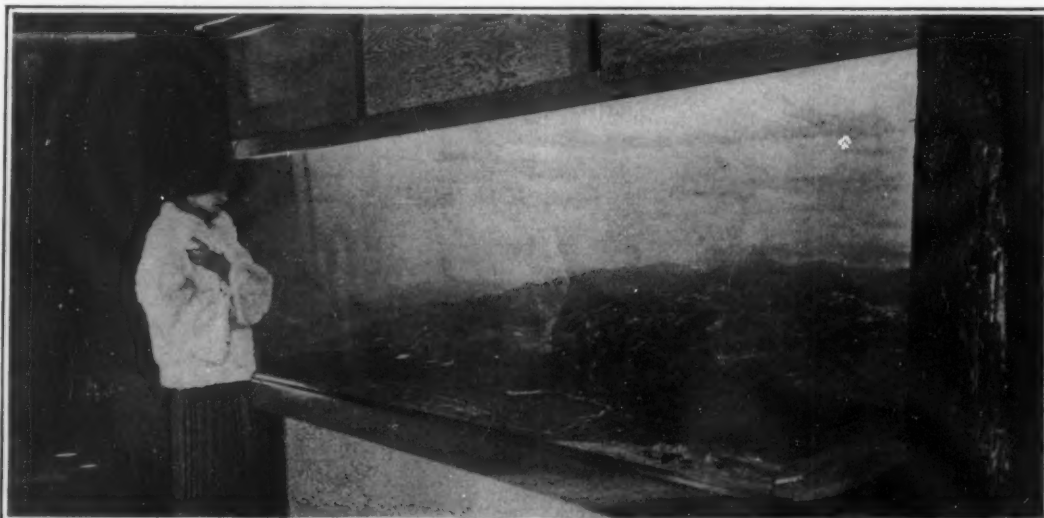
being made under exceptionally good conditions, a far greater depth than is possible with the cable-tool in normal circumstances. Further facts in favor of the system are that high gas and oil pressures are more easily controlled, less casing is required for the lining of the well, it is less costly to employ than cable-tools, and it is more universally adaptable to conditions of modern oilfield development. Two inherent disadvantages are the tendency through "mudding" for the driller to miss oil shows, and the difficulty of obtaining uncontaminated samples for elucidating subsurface geological data. The first depends for its solution on the efficiency of the driller. The second has been lately successfully

combated by the introduction and use of the core-barrel, by which adequate sampling can be carried out. The rotary system finds its greatest exploitation in California and the Mid-Continent fields, and has materially contributed to the development of the field.



Tracing to scale, from a small map on to the baseboards for the big one, the outlines of San Francisco city and the adjoining rivers and bay

out of every port. Locations are very accurately established, and the buildings in the center of each city are actually recognizable, so carefully have they been modeled. Blue lakes and reservoirs, and colored areas help to show the exact extent of irrigation, and where each



A fifteen-foot section of the map, finished and mounted to show the effect of the subdued interior lighting

A New Portable Microscope for Use in the Shop

THE examination of metals, particularly steel, under the microscope, has become one of the essentials in the metallurgical control of the steel and some other metal industries. It has heretofore been necessary, however, in order to examine metals under the microscope, to cut pieces from certain sections and submit them to microscopic examination in the laboratory. The object of such examination is, of course, to determine the size of the crystals and the condition of the metal after certain processes to which it has been subjected. It is also used for the detection of flaws, cracks, etc.

There has long been a demand for a microscope which could be used in the shop, that is, which could be efficiently employed to examine metal outside of the laboratory and without the destruction of the piece to be examined. For instance, there are often cases where it would be desirable to examine the surface of a crank shaft or an axle under the microscope but this has been impossible with apparatus heretofore constructed.

There has now been put on the market, however, what is known as a portable microscope. It has been developed by a firm in Jena, Germany, and is entirely different from the usual metallographic microscope employed only in a steel laboratory. It has been introduced in the American market. The illustrations give some idea of the construction of this new device. It is sufficiently rigid and easy to apply so that it may be given into the hands of the foreman of a shop for the inspection of work during any stage of finishing, or for making tests in connection with the heat treating department whereby valuable information about annealing periods, temperature for hardening, means for carbonizing, etc., may be obtained. It is also stated to be useful for settling difficulties with customers and suppliers of material. As our illustrations and text will make clear, the new microscope works directly upon the piece to be examined, without any preliminary sectioning, etching or other preparation.

One illustration shows the optical arrangement. The illuminating device (a) for day or artificial light reflects the light to the prism (b) from which by the aid of the objective (c) it is directed upon the specimen of metal (d). The other prism (e) directs light reflected particularly by (d) into the ocular (f). The microscope can be applied to shafts and other cylindrical pieces as shown by another illustration in which jaws are shown made in two sizes and so arranged that their distances can be varied by means of screws. If it is desired to examine under the microscope shoulders and billets in crank shafts, and other similar forms, this can be done in much the same way and with equal ease.

Undoubtedly such a portable microscope will find wide use in the steel and metal-working industry because of its practicability and the fact that it can be used to examine many forms of steel without destroying the objects to be examined.

An Old Canal Put to Use

A DISUSED canal in Wales has been put to use to convey a pipe line to supply Cardiff with water. The canal is now used only by a few patent fuel and other factories which are conveniently served by railway. The use of the upper reaches of the canal for the

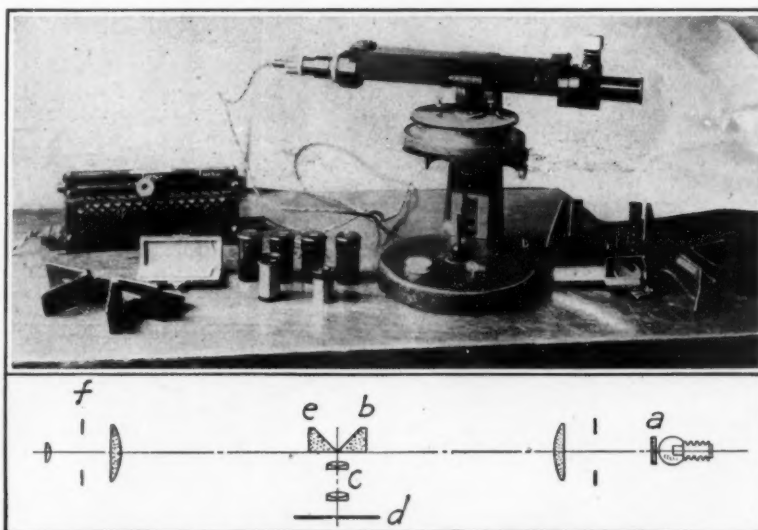
pipe line saves enormous expense in trenching besides providing an easy route free from way-leaves. The acquisition of the remainder of the canal would greatly facilitate town development to the north of Cardiff, removing the necessity for many bridges, while it would provide a new thoroughfare through the heart of the city and permit the demolition of several very bothersome saddleback bridges.

Keeping Them Down to Eleven Tons

OREGON traffic officers are using a new type of scales to weigh trucks to see if their loads do not exceed the 22,000-pound limit set by the State laws. The scales, which are the first of their kind to be used in the West, are very handy. They are small and can be carried about by the traffic officers. When a heavily loaded truck is encountered the scales are placed in the street and the driver required to drive upon them. They are found a big help in enforcing the law against overloading, presenting obvious advantages over permanent scale installations whose locations would soon be known to potential violators of the law.



Roadside scales for enforcing Oregon's weight limits on loaded trucks



Above: General view of the entire apparatus. Below: The optical arrangements, presented diagrammatically

The microscope that can be taken into the shop and set up for use in a hurry, without special preparation of the specimens

Machine for Testing Airplane Ribs

IN order to test the ribs for airplanes, a special machine has been devised that has many distinct advantages. The most unique and valuable feature is the opportunity that is offered in the case of wooden ribs for changing the strength of the rib while it is being tested. For example, suppose that a rib is found to be considerably over strength; then the section of the diagonals, verticals or webs can be cut down while the rib is still in the machine. Thus the rib may practically be designed while it is under load.

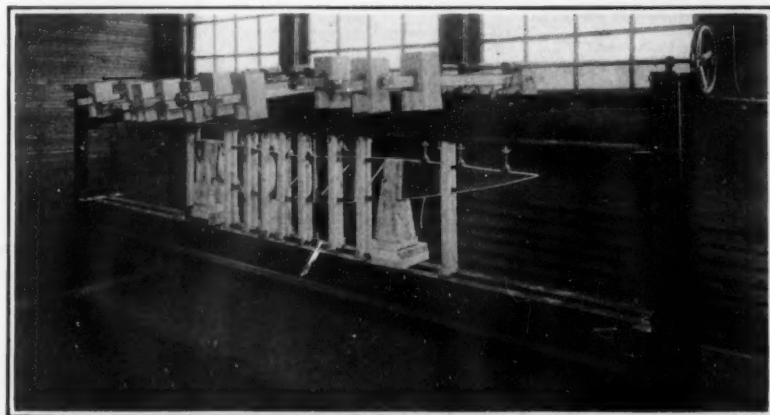
The loads, which may be varied in amount, are applied by means of sliding shot cups mounted on graduated lever arms. The arrangement is such that the loads are moved simultaneously by means of a hand wheel located at one end of the machine. The load is applied to the rib by vertical rods provided with shoes at the ends where they come in contact with the rib. The length of the rods is adjustable to allow for the deflection of the test specimen. The direction of the loads is easily reversed as in the case of the nose load in a high

speed condition, by simply extending the lever arm on the other side of the machine. The arms are balanced at the start of the test by means of sliding lead counterweights. The effect of a uniform load is obtained as nearly as possible by accurate location of the loading arms and the use of distributing blocks under the shoes.

With this machine any type of rib may be tested, whether from wings, tail surfaces or control surfaces. As it is necessary to weigh out only one set of loads no matter how many factors are required, accuracy of weights is obtained and therefore efficiency. As the rib is easily accessible while in the machine, the failures are easily detected and due to the stops on the weight arms the rib is not completely destroyed after the initial failure.

Stellar Evolution

TO KANT and to Laplace we owe the first rational hypothesis of stellar evolution, but they had at their command insufficient data to establish their nebular hypothesis on a sound basis. Within the last few years astronomers have accumulated a great mass of material which gives a more secure foundation for a consistent theory of stellar evolution. In the case of hundreds of stars much is known concerning their distances, their sizes, their densities and their temperatures. From the laws of physics we know the general trend of the changes which must take place in any star. If at first it is a highly rarefied and diffuse mass of vapor at a low temperature, gravitational forces will cause its gradual condensation, and this will produce an elevation of temperature. Just as the air in an automobile tire becomes hot as it is compressed. As the temperature rises, the vapor will first become red hot and ultimately white hot. After the density reaches a certain stage, condensation will proceed more slowly. When the loss of heat by radiation exceeds that produced by compression the star will cool in reverse order from white to red heat. After it has contracted to the solid state, like the earth, the production of heat by condensation will cease, while cooling by radiation will continue, until the star loses its luminosity. Condensation and cooling will be extremely slow, and may be prolonged by internal development of heat due to superchemical transformations made possible by enormously high temperatures and pressures. These may cause the formation of one element from another by the aggregation of atoms. If such be the sequence of change in any star, it is evident that it must pass through the red stage twice, the first time while rising in temperature toward the white state and again while cooling. It is an established fact that there are many huge dark nebulae which may be the original stuff of which stars are made, and that the red stars can be separated into two well defined classes of giants and dwarfs, differing enormously in size and density but little in mass. These large differences in size are not found in the white stars, which are all, according to this hypothesis, in the same stage of development. What may be the final destiny of the dark bodies which are the final product, we can only guess. Hundreds of thousands of such dead and invisible worlds must exist, most of them perhaps destined to wander through space for all time, but some of them may, by collision with other bodies, be again resolved into glowing vapor and begin a new cycle of existence.—Abstract from article by Professor E. P. Lewis, in *Science*, for November 23, 1923.



Testing airplane ribs without destroying them

The Story of Steel—VI

Open-Hearth Furnace, Making a Superior Steel, Supersedes the Bessemer Converter

IT WAS because the Bessemer converter rendered it possible to make steel with great rapidity and at low cost, that its inventor, Henry Bessemer, will always remain the outstanding figure in any history that may be written about the steel industry. To think of steel is to think of Bessemer.

In 1854, Henry Bessemer invented his Bessemer or pneumatic process in England, and about the same time William Kelly of this country, quite independently came out with a process of making steel, also using a blast of air as the means. After considerable litigation, a compromise was made, and today we know the pneumatic process by the name of Bessemer.

In 1861, Siemens developed his regenerative furnace, the underlying principle being as follows:

The hot gases are passed over the furnace body and thence through a series of checker brick and on to the stack. The direction of the flame is then reversed, the air being taken through these hot checkers, absorbing heat and thus yielding a high temperature on uniting with the fuel. This continued reversal leads to a gradual increase in flame temperature, which is today the basis of open-hearth work. It was in 1864 that this important principle was developed by Martin and hence open-hearth furnaces are called today Siemens-Martin furnaces.

The limitations of the Bessemer process did not hold for the open-hearth, since it became possible to use materials of a greater variety. The process of refining is much slower, ordinarily from 8 to 12 hours, but it becomes possible to exercise a very close control of the reactions, make frequent tests of the metal in the bath, and secure a steel of the exact composition required. So marked are these advantages, that in the specifications for high-class construction, such as bridge building, where a very exact relation between the working stresses and the strength of the materials must be secured, there is an invariable call for open-hearth steel.

The advantages of the open-hearth process are summed up by those who are versed in the art, as follows:

1. By the use of ore as an oxidizing agent and by the external application of heat, the temperature of the bath, that is, of the materials in the furnace, is made independent of the purifying reactions, and the elimination of the impurities (carbon, silicon, manganese, etc.) can be made to take place gradually; the temperature and composition of the bath being under much better control than in the Bessemer process.

2. For the same reason, a greater variety of raw materials can be used and a greater range of products made.

3. A very important advantage is the increased output of finished steel which can be secured from a given amount of pig iron; hence fewer blast furnaces are required to produce the same tonnage of steel. This is explained by the fact that the Bessemer process uses all iron in molten form, whereas the open-hearth process can use iron in smaller proportion of the total charge, together with scrap.

4. With the development of the basic process, it was found that the greatest advantage of the Siemens-Martin over the Bessemer was the elimination of phosphorus. While the basic Bessemer process requires pig iron with a phosphorus content of 2 per cent or more in order to maintain the temperature necessary for the reactions, the basic open-hearth process permits the use of iron of less limited phosphorus content.

In 1908, the open-hearth process surpassed the production of the Bessemer and today it may be said, roughly speaking, that the open hearth produces one hundred tons of steel for every twenty made by the Bessemer process. Natural gas, which was formerly used in open-hearth furnace work, by its severe limitations in supply, has been replaced as a fuel by producer gas, a product from the gasifying of coal in gas producers; by tar and by-product gas, fuel by-products

beams or channels resting on piers entirely independent of the rest of the structure.

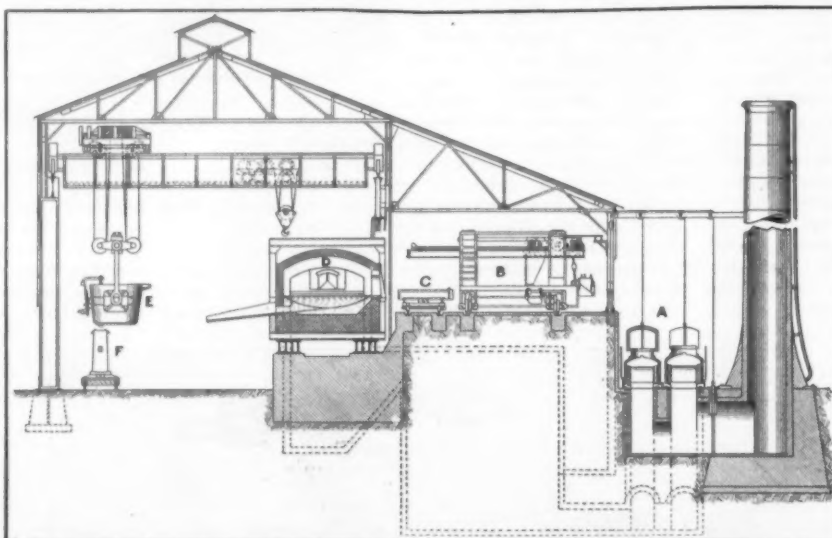
In a basic furnace the bottom is made up of several courses of clay brick, upon which is placed a deep lining of magnesite, curved upwardly all around to form a trough-like basin. This magnesite—a highly refractory material, is mixed with ground basic slag, and it is then set by slow heating and gradually brought up to a high working temperature, thus fusing the bottom. The acid furnace is constructed in the same fashion, except that silica sand is used, in place of grain magnesite. Furnaces today are practically all basic, and range from a capacity as small as 5 to 15 tons for making special steels to as large as 125 tons. The average capacity today is from 60 to 75 tons per heat.

The open-hearth process varies in different districts, depending upon the available pig iron and the scrap conditions. A typical plant in the Pittsburgh District charges a furnace as follows:

Raw materials, such as limestone, ore and scrap, are assembled in a stock yard; in some cases the limestone and ore being in bins and dropped directly into charging boxes, which are usually 20 inches wide, 20 inches deep and 6 feet in length. The various scrap is loaded into the boxes by magnets. All these materials are then assembled into a "heat" and a small engine pulls this load into the open-hearth building, leaving it to be handled in the next step by the almost-human charging machine. This machine has an arm which locks into the end of the charging box, and can be pushed in towards the furnace and revolved. The door of the furnace is opened, the box is picked up and thrust into the furnace, the arm is revolved, dropping the material on the hearth of the furnace, and the box withdrawn.

Limestone is placed on the basic bottom, then ore, then a certain amount of scrap, approximately 40 per cent of the total metallic charge. The charge is melted by burning fuel in the port end of the furnace in conjunction with the highly preheated air that has come through the checker work; as mentioned before, thus yielding a very high temperature of combustion. With the reversals in flame direction at intervals of 20 to 30 minutes, the charge is gradually melted down. This mass is heated until the scrap is white hot and slightly fused; then molten pig iron is added. This is taken from a mixer, which is a storage body for the hot iron coming from the blast furnaces, whereby uniformity in the quality of the iron is secured and a steady supply of hot iron for the open-hearth furnaces maintained. The mixers are usually of from 300 to 1000 tons capacity.

With a scrap content of 40 per cent of the metallic charge, the molten iron would then be 60 per cent of the total when added. With the addition of this iron there occurs a lively reaction, during which almost all of the silica, manganese, phosphorus and part of the carbon are oxidized or burned out by the oxygen, the first three forming compounds that slag with the iron oxide and join the iron and lime silicates which have already been melted. At the end of two or three hours about 80 per cent of this slag is drawn off. The ore acts on the carbon for three or four hours longer, the limestone being decomposed by the heat; and the carbon dioxide, bubbling up through the bath, exposes part of the metal to the flame, oxidizes it, and completes the purification (Continued on page 439)



To the extreme right is the stack. Then follow: A, air and gas reversing valves; B, charging machine; C, buggies, from which charger picks up boxes of "mixture," thrusts them into furnace D and empties them; D, furnace, with charging door (right) and pouring spout (left); E, ladle cranes, with ladle F over mold F pouring an ingot

Sectional view, showing relative positions of parts of an open hearth plant

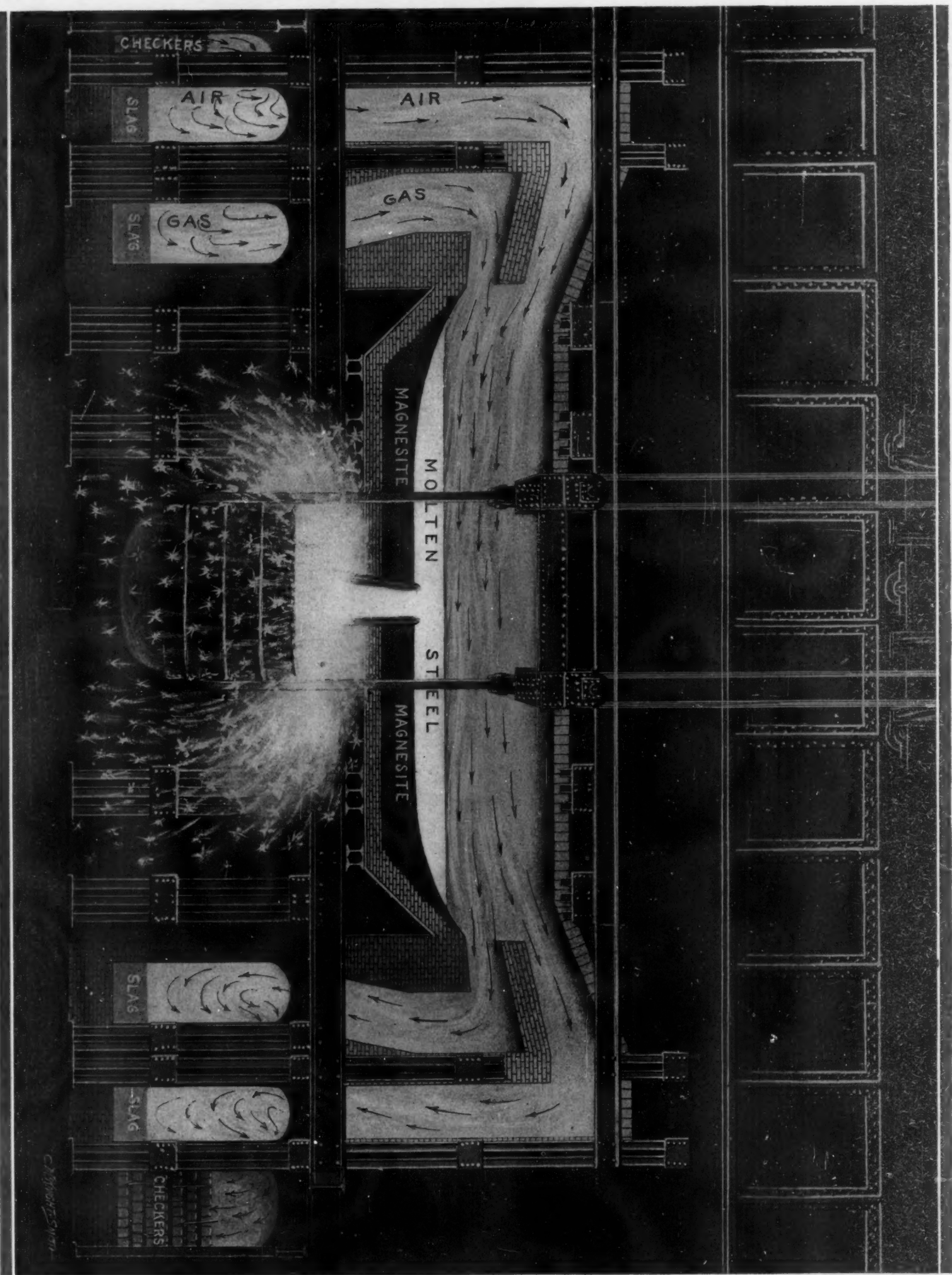


This shows the charging platform of a long line of open-hearth furnaces, with a ladle emptying its charge of hot metal into a furnace

in the coking of coal; and in later years by fuel oil.

The open-hearth furnace, as shown in the illustration on the adjoining page, is a large rectangular structure, approximately 15 feet wide by 35 to 40 feet in length. At each end of the furnace are two large openings or ports, one to admit air and the other gas. The roof is of silica bricks, 3 inches by 9 inches by 15 inches deep. This highly refractory material is built in the form of a flat arch to give it strength and stability; and the whole furnace is held in place and tied together by heavy beams and tie-rods. The hearth or bottom of the furnace rests on steel plates which are carried by

action, during which almost all of the silica, manganese, phosphorus and part of the carbon are oxidized or burned out by the oxygen, the first three forming compounds that slag with the iron oxide and join the iron and lime silicates which have already been melted. At the end of two or three hours about 80 per cent of this slag is drawn off. The ore acts on the carbon for three or four hours longer, the limestone being decomposed by the heat; and the carbon dioxide, bubbling up through the bath, exposes part of the metal to the flame, oxidizes it, and completes the purification (Continued on page 439)



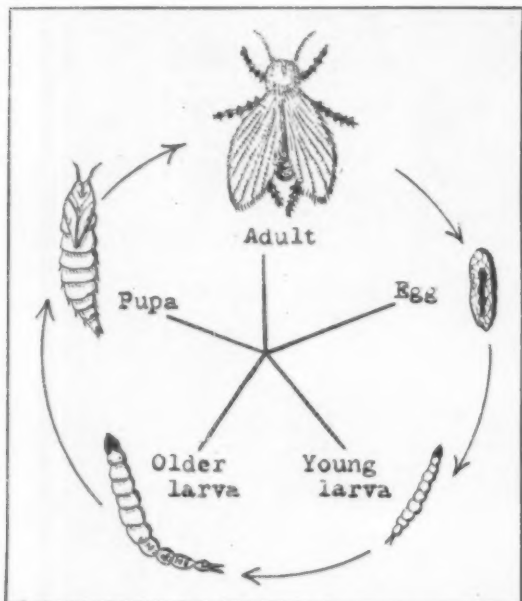
OPEN HEARTH FURNACE, SHOWING THE CHECKER WORK, GAS AND AIR FLUES, AND THE BATH IN WHICH 100 TONS OF METAL ARE REFINED TO STEEL. THE STEEL IS BEING TAPPED INTO A LADLE WHICH IS SUSPENDED FROM AN OVERHEAD TRAVELING CRANE

Birds and Sewage Disposal

An Interesting Relationship Involving the Relief of a Filtration-Plant Nuisance

By Leon Augustus Hausman, Ph.D.

Assistant Professor of Zoology, Rutgers College



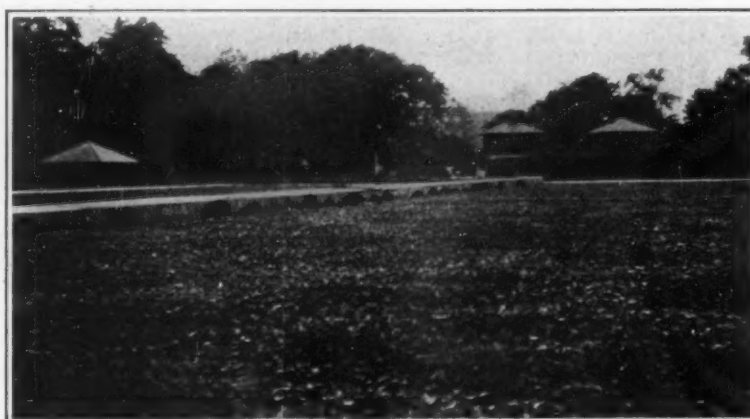
All stages occur in the filter film save the adult, and the birds feed on all stages except the egg (much enlarged over the other stages in this drawing)

The life cycle of the sewage-filter fly

ONE of the most disagreeable features of a modern sewage disposal plant (in which a sprinkling filter is used for purifying the fecal sewage) is the presence of immense numbers of small, grayish, fuzzy flies, of the species known as *Psychoda alternata* and *Psychoda cinerea*, or sewage sprinkling filter flies (center views). These flies breed in countless numbers among the loose stones of the filter bed, and fly, or are carried by the wind, often to the distance of nearly a mile. Were their presence confined to the locality of the immediate neighborhood of the sewage disposal plant they would not be so great a pest, except to those working around such a plant; but they enter dwelling houses at considerable distances from the plant, and penetrating the finest screens make their way to all parts of the house, where they fall into the food, and make themselves troublesome in many ways. They are regarded with disgust and fear—because of the character of their breeding grounds—and there exists a not unreasonable presumption that they are the carriers of infections and diseases. Nearly all sprinkling filters are breeding grounds for these pests.

In a disposal plant where the sprinkling filter is used the water from the incoming sewage is allowed to sedi-

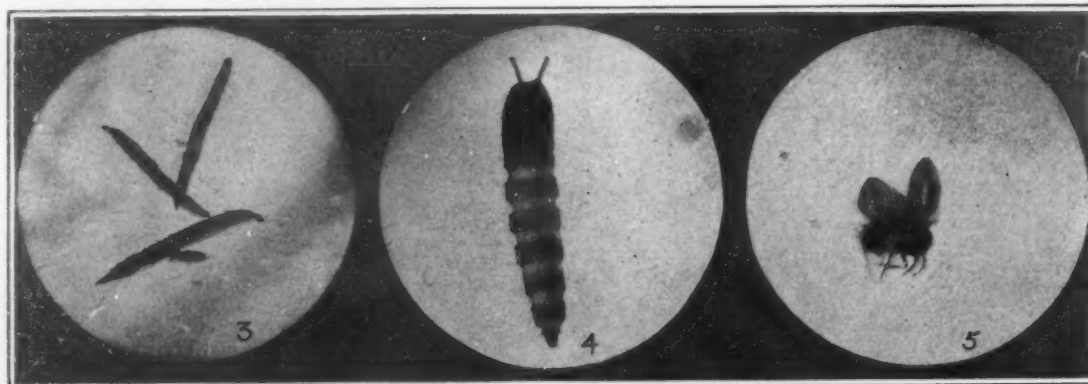
ment out a portion of its suspended solid materials in large tanks, and is then sprayed out, by means of a multitude of nozzles, over a bed of stones, through which the water percolates and is purified, before it is allowed to drain off—usually into some neighboring brook. A typical sprinkling filter bed, with its sprays in operation, is shown herewith. Such a bed is about six feet in depth and is composed of irregular basaltic stones, of about the size of small hen's eggs, resting upon conduits which lead off the purified water. On the stones over the surface of the bed there usually flourishes a rich, greenish mat composed of *Oscillatoria* and other algae forms; and on the under surface of these surface stones, and continuing to the bottom of the bed the stones are covered with a heavy, slimy accretion, made up of various fungi and water molds, with entangled bacteria growing in a gelatinous matrix. Numerous microscopic organisms find the op-



Portion of the filtration bed when the sprays are idle, showing the loose stones among which the *Psychoda* fly breeds

The most successful method yet devised for the control of the filter fly was worked out in the New Jersey Agricultural Experiment Station, and consists in flooding the filter bed with the incoming sewage (by closing the outlets) and then leaving them completely submersed for a period of twenty-four hours. Such treatment of the beds kills the *Psychoda* larvae and pupae by drowning.

While engaged in some investigations for the State of New Jersey on the animal population of the filter beds of the Plainfield, N. J., sewage disposal plant, the writer had opportunity of observing the various stages in the growth of the filter flies, and also of noting a singular and hitherto apparently unappreciated natural check upon the growth of these noxious forms. This natural check is the work carried on, during the winter, by several species of native



3: The larvae as they hatch from the egg, magnified about ten times. 4: The pupa or transformation stage, magnified about 15 times. 5: The adult fly, magnified about 10 times

The sewage-filter fly in various stages of growth

timum conditions for their growth in such a film and increase in numbers with the gradual growth of the film.

It is in this film that the filter flies breed. The eggs are laid on the surface of the film, and the larvae, or young, upon hatching, work their way into it. Here they remain and feed, and after their pupal change, they emerge as adult flies. The film upon the stones collects, and grows in thickness during the winter and early spring, and with this growth there occurs an increasing number of flies. Hence in the early part of the season the pests reach their maximum numbers. A single square inch of stone may contain film enough to harbor from forty to seventy larvae. Even in midwinter it was found that a single stone from near the surface of the bed supported nearly a hundred larvae and pupae. Breeding in the film goes on from the top to the bottom of the bed, but is concentrated usually in a zone extending from three to twelve inches below the surface.

birds, namely: the song sparrow (*Melospiza melodia*), the goldfinch (*Astragalinus tristis*), the tree sparrow (*Spizella pusilla*), and the junco or snowbird (*Junco hyemalis*). Flocks of these birds numbering from fifty to one hundred and fifty individuals were often seen flying about the filter beds, with the juncos and song sparrows much the most numerous. At times two or more separate flocks were observed about the beds, making a total of about three hundred birds. Close attention to their movements showed that these birds were securing food from the surface of the filter beds, working rapidly between the periods of the activity of the sprays, which were of two minutes' duration. Microscopic examination of the film showed few or no weed seeds, which are the chief constituents in the dietaries of the birds mentioned. The only larger forms of life present in or on the film were the filter fly adults and young, and it was these forms for which the birds were in search. From observations of their feeding activities it was judged that each bird secured one bit of food (presumably a *Psychoda* adult, larva, or pupa) every two seconds, making thirty individual organisms per minute for each bird, or 1800 per hour. This would make a total of 270,000 organisms per hour for a flock of 150 birds, or over half a million where the number of birds was 300. And if only 150 birds were at work on the filter beds, let us say four hours daily, the number of organisms consumed would total 1,080,000! Thus flocks of birds working on a filter bed during the entire winter would aid in a material way in keeping the *Psychoda* flies in check.



In the open spaces, kept clear of ice and snow by the sprays, the birds do their feeding
The filter bed in mid-winter, with the sprays in operation

Fighting Forest Fires with Radio and Plane

IN fighting devastating forest fires in northern Ontario, Canada, man's conquest of the air is playing an important part. Today eight planes are engaged in daily aerial patrols over more than 80,000 square miles of virgin timber. The planes make their headquarters at Ramsay Lake, Ontario, where the provincial government in conjunction with a privately operated air service maintains the first radio station devoted to fire patrol service in middle northern Ontario.

The annual loss of standing timber by forest fire in the Ontario regions has been appalling. The losses have increased annually by almost a million dollars. There are few settlements in the timber belt hence no men to range the country for fires or to fight them. This year, it is announced, the loss will be cut by a million dollars. The cooperating radio and planes are given credit for the favorable change.

The planes in use are the SE type, manned by ex-war aviators, one of whom was an ace in the Royal Canadian air forces. Four of the eight planes are equipped with radio transmission sets and the others will have them in a short time. The power for transmission is derived from a generator driven by a separate small propeller.

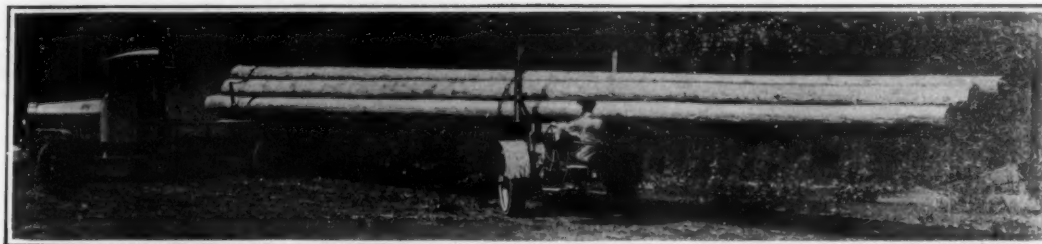
The aerial for broadcasting is on a coil in the cockpit and the end is tied to a weight so that when the plane has taken to the air the aerial is paid out about 100 or 150 feet. The weight keeps it suspended downward without interfering with the propeller. A fifty watt oscillating power tube is used and the circuit is of the well-known feed back type for transmission. Generating power is as high as 1000 volts. The sending is about 555 metres but can be raised to 900. It is most practical to send on a very high wave.

The communication established between plane and the radio station built on a rock in Ramsay Lake, enables the patrol, which first sights the fire, to call other planes into fire fighting action. When an observer flashes the ground station that fire has been sighted he gives map co-ordinates; and planes with specially built, gas driven centrifugal pumps and as much hose as the plane will carry, are dispatched to fight the fire.

Frequently it has occurred that planes were unable to find a landing place near the fire and have been forced to drop pumps into shallow lakes. A buoy is attached in this emergency and later the pump is fished out and put into service. Several times bombing from the air has been resorted to where the fires were discovered too late for a small pump to be of service.

Psychology and Criminal Responsibility

IN A recent number of *Psyche*, Dr. W. Brown discusses the attitude of modern psychology to responsibility. He shows that there is a tendency for those who understand incompletely the aims of modern psychology, to believe that a general spread of its doctrines will result in a weakening of the sense of moral responsibility. He discusses the legal definition of responsibility and describes cases where a crime of violence may be committed for which the person cannot be held responsible. The psychologist, as such, is concerned with the problem of studying the causes in the history of the person which have led to the act, and the contribution of recent work is in the direction of tracing the influence of the acts and phantasies of infancy and

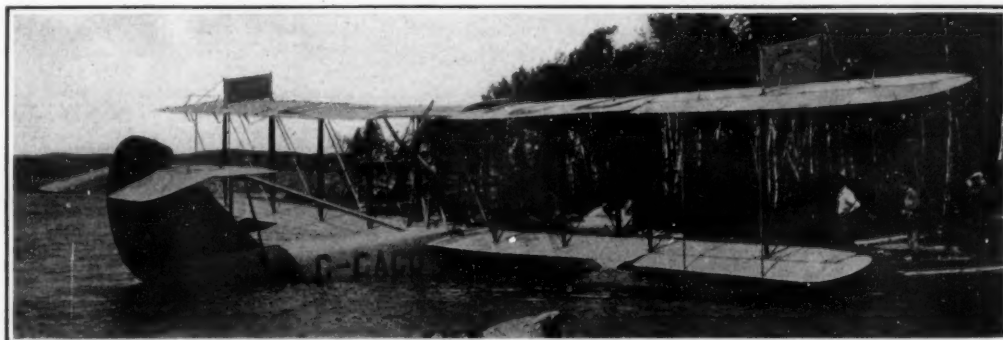


German trailer with steering gear, designed to carry the other end of long loads, and keep the big poles out of mischief on the corners

childhood; it appears not infrequently that the people answerable for the victim's upbringing were really responsible. Modern psychology does not contest the reality of moral responsibility. While it holds the view that criminals suffering from certain forms of mental disease are less fully responsible than are normal people, it does not countenance the view that all criminals suffer from mental illness, nor that mental illness is an invariably sufficient excuse for crime.

Where the Load Carries the Trailer

THE transportation of extremely long structural units—poles, girders, etc.—is always a problem. We have seen traffic in New York completely disorganized by the passage through the streets of the huge girders for the bridge across 42nd St., joining the concourse around the Grand Central Station with the central roadway of Park Ave. These are the longest single loads that have ever been attempted in this city, with the exception of the obelisk in Central Park; and this



Canadian fire patrol returning to his base after nine hours of continuous flying in cold air

was taken up from the docks to its present location many years ago, at a time when horses were the only available motive power, and traffic was far from its present congestion.

The mere presence of an extremely long load on the road is in itself a good deal of a nuisance, complicating as it does the problems of passing. But when such a load reaches a turn, we find it at its worst. All the difficulties and dangers cannot be eliminated, of course; they are inherent in the situation. But we present two pictures showing the use of a special trailer now being made by the reformed Krupp works in Essen, Germany, which is especially designed for this sort of thing. The upper view, showing it handling a load of poles, gives the best idea of how it works; and the very daring stunt of the lower photograph, in which a completely assembled steel tower of considerably more than fifty feet is being handled, shows the extreme possibilities.

As the closer view suggests, there is no physical connection between truck and trailer, other than that

afforded by the load itself. This of course is quite sufficient to hold them together. In negotiating a bend, it is not feasible to permit the trailer and the end of the load to cut the corner as they would if left to themselves, and as the rear wheels of the ordinary car and truck now do. The trailer has to track more or less closely after the truck; and so it must carry its own steering gear and its own steersman. The pole picture gives a very good idea of the behavior of the trailer and of the load under these conditions.

Clothes Moths and Their Control

AMONG entomologists there are well known to be two very common moths the larvae of which are destructive to fabrics; namely, the case-making clothes moth and the webbing clothes moth; the tapestry moth is much less frequent, but is occasionally destructive.

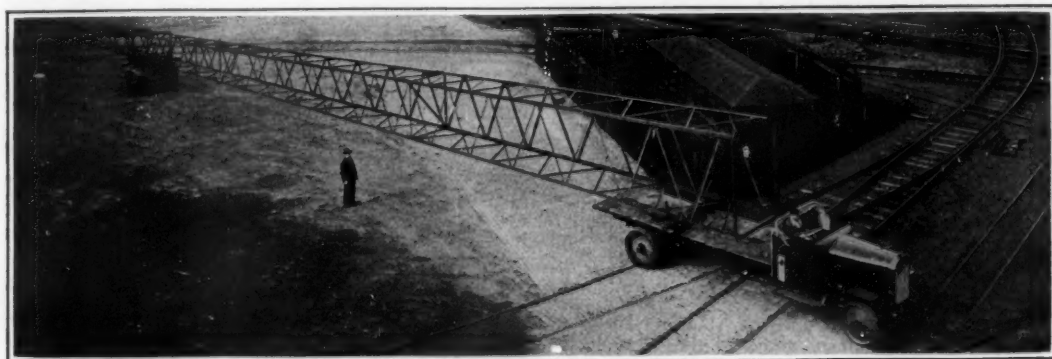
In general, the larvae of clothes moths feed upon wool, fur, feathers, hair, and all fabrics manufactured from them. It will therefore be realized that they may

be found attacking not only clothing but also carpets, rugs, furs, upholsteries, stuffed animals, brushes, felts in pianos, and the like. The moths are relatively short-lived; they take no nourishment and are in themselves harmless. Their eggs are laid upon or between folds of fabrics or within the meshes of the latter. They are readily crushed by brushing, etc., and are very fragile. Under average indoor conditions they hatch in about a week, this period being subject to lengthening or shortening according to temperature. The

larvae are relatively long-lived and require from about fifteen weeks to two years to complete their development. Much depends upon the nature of the material upon which they are feeding and the temperature conditions under which they exist. The pupal, or resting period varies from about eight days in warm summer weather to a month or more in winter.

Methods of dealing with these pests are numerous. Fabrics that are well brushed or beaten every two weeks are seldom seriously affected; exposure to direct sunlight is also a valuable measure. Articles of clothing that require to be stored are immune from attack if sealed down in paper bags, or very securely wrapped in several layers of quite unbroken newspaper. Naphthalene, in the form of flakes or balls, should be placed among the clothing thus fastened up. It also acts as a deterrent when placed in drawers or cupboards, but is not entirely effective under such conditions. Paradichlorobenzene appears to be as valuable as naphthalene, but camphor is decidedly less effective.

On a large scale, the cold storage of furs, carpets, and furniture is the most certain of all preventives. An effective remedy, which is also non-injurious to furniture, fabrics, plate, or other household goods, is the application of hydrocyanic acid gas. Its manipulation requires the services of an intelligent person who understands the dangers of its use and knows how to administer it. Carbon tetrachloride is also effective, and has the advantage over hydrocyanic acid gas in being neither explosive nor inflammable. Fumigation with sulfur is a well-known remedy, but there is some danger from fire in its application, while it has a bleaching effect on many delicate fabrics, wallpaper, etc., besides tarnishing metals. Carbon disulfide is also recommended, but its vapor is inflammable. Dry heat is now recognized as an effective agent. All fabrics will be freed from pests in a very short time if exposed to a temperature of 130° F. Fabrics dipped in water heated to 140° F. will be found to contain no living eggs or larvae of clothes moths.—Abstract from article by A. D. Imms in *Nature*, December 15, 1923.



A spectacular piece of hauling that was successfully engineered with the steering trailer. Note the absence of any connection between truck and trailer other than that afforded by the load itself



ONE of the highest-priced schools in the world is operated by Uncle Sam himself, at Madison, Wisconsin, where each registrant pays \$100 for a one-week course, at the rate of \$5200 a year for tuition alone.

There may be occasionally heavier collateral bills for the college veneering of coltish boys and girls with jazzy tendencies. But this federal school is for hard-headed business grown-ups.

It is conducted by the Forest Products Laboratory, the technical wood-usage department of the Forest Service. Its four instructional courses, given three times yearly, cover that number of broad fields of wood use and adaptation, the specific courses being Kiln Drying of Lumber, Boxing and Crating, Gluing of Wood, and Wood Properties and Uses.

Practically everybody feels that Nature has already given him the essential facts about wood. It's a tall tree stuff that grows outdoors, they use it for Christmas trees and boxes and houses, it rots and needs interminable painting and paint costs big money, and raucous agitators shout "Woodman Spare that Tree" and "Save the Forests" and many other nifty words. And yet the Laboratory's skilled investigators have found out and put into these lecture courses many valuable things that the average wood authority doesn't yet know.

About 400,000 houses are built in the United States every year; 98 per cent of all farm and rural houses are still built of wood, and fully 75 per cent of all in the cities. How long should a wooden house stand? About 80,000 American buildings are destroyed yearly. Fire and decay are important factors in this destruction; indeed, the total annual wood loss by decay alone almost equals the present growth in all the American forests. The Laboratory shows that decay is the growth of living fungi that can be largely controlled by knowing what decay is and how to preserve the wood or to build so that decay does not start.

During fourteen years of intensive study the Laboratory has made more than 600,000 strength tests of woods. Just how strong should structural timbers be? A large building failed as it was approaching comple-

Uncle Sam's High-Priced School

tion; it was through the mercy of God and not the builder's wisdom that men were not killed. Did the architect understand wood strengths well enough to provide sufficient margin for safety? The Laboratory, when appealed to, showed that failure had been due to overload even before the building was finished, and that not enough margin had been allowed for safety. Many buildings fail disastrously through lack of knowledge of wood strengths.

A telephone company experienced serious losses in shipping its switchboards. Could the Laboratory, from its fundamental knowledge of boxing and crating, suggest packing methods to prevent this breakage loss that the telephone public must pay? A trunk manufacturer wanted to build a trunk that would defy the baggage-smasher. He sent some \$50 trunks for the Laboratory to test to destruction, and find the weak spots and how to remedy them.

A lamp-chimney maker encountered an excessive shipping breakage. Was there not some way to pack fragile lamp chimneys so that they would travel safely and cost the people less money? Too great loss was occurring in the shipment of automobile tires and tubes. The Laboratory used up \$3,000 worth of new factory rubber in showing how these goods could be shipped safely. These are a few of the many cases in which the Laboratory has cooperated with manufacturers to solve difficult problems that affect almost every home, and that help furnish the data for a great technical school.

The railroads were paying \$90,000,000 a year for freight damaged in transit. Laboratory investigation showed that greater shipping safety might be had by adopting proper principles of container design, in the application of bracing, banding and nailing methods. A campaign for better packing and handling cut the loss by \$45,000,000 in one year.

What kind of wood does one actually get when buying by name? Sometimes it is important to know. One company bought some sawdust for an especial use.

The shipment did not seem to meet the visual requirements, and the buyer protested. Microscopic analysis at the Laboratory showed that the consignor had sent what was ordered and the dispute was easily adjusted.

A county officer was the victim of a bomb that crippled him and killed his wife. Suspicion pointed to a man with whom the county had had trouble. A piece of wood was used in constructing the bomb. Some of the shattered splinters were sent to the Laboratory for identification. The suspect's workshop contained shavings of the identical kind of wood, and as a result of this and other evidence conviction was secured.

For its last dry-kiln course the Laboratory had 25 students from 14 states and two foreign countries. Other courses are for one week only; the kiln course lasts two weeks and costs \$150. Already this one department has had more than 300 students.

Kilns for drying lumber have been used in the United States for three decades, but have come into really great prominence only in the past few years. Lumbermen and wood users are finding them more and more an economic necessity. Comparatively few students come to study for initial kiln installation; they want to know how to operate their present plants better. The Laboratory for the past 13 years has made an intensive study of dry-kiln methods, and its kiln-drying specialists have a world-wide reputation. It has itself developed several basic kiln patents which are formally dedicated to the public. It is the nation's and the world's dry-kiln schoolmaster.

With a thousand blank pages in the popular book of knowledge concerning woods and wood uses that only the Laboratory can fill, the appropriations still contemplate nothing but research work. Instructional service can be rendered only through the cooperation of those sufficiently interested to pay the enrollment fees. The instruction is given on a far-less-than-cost basis for the extra service, by men recognized as national authorities in their particular lines of investigation, to give the business world every Laboratory method, every discovery of value, and put it to work.



ALTHOUGH easily the most extensive and perfected radio communication system in the world today, this net has been little known to the public. The great network, tying in every city of tactical importance in the United States with Washington, and with the nine Corps Area headquarters, was planned as a training measure and to provide communication during any local or national emergency during which land lines might fail. It was given as little publicity as possible until its seventy-five stations could be installed and welded into a smoothly working system, free from interference and causing none to other stations.

The net has its origin in the "Army Radio Net" as employed in the First and Second American Armies in France, prior to the Armistice of 1918. The Signal Corps, therefore, lacked neither inspiration nor experience in its creation, for the Army nets in France were created and operated in an atmosphere of enemy interference beyond comprehensive description.

The project was approved by the Secretary of War, March 12, 1921. At the very outset the Signal Corps had the distinct advantage of being able to start with the most modern continuous wave equipment available in the world. No obsolete spark equipment had to be patched into an otherwise perfect pattern. Remote control of transmitters, providing simultaneous, or multiplex transmission and reception, was known to be as necessary as power to operate the transmitters, and was provided. The first receiver installed in the net employed a directional loop with a six stage radio-audio frequency amplifier and external heterodyne. Nothing new in the art was overlooked in the initial engineering plans, nor has anything since been overlooked which might improve the net's efficiency.

All stations are within military posts where they can be guarded. Auxiliary sources of power supply provide emergency power in the event of failure of a commercial source, and spare parts are provided so that failure of a vital unit is never serious.

With one exception, all stations of the War Department net are radiophone, as well as radio telegraph, this feature being provided against possible future requirements.

The War Department net proper connects the nine Corps Areas of the United States with each other, and with Washington. Each of the nine Corps Areas has its own comprehensive Corps Area radio net, connecting with its headquarters all tactically important points within the Area.

The War Department Radio Net

The American Radio Relay League, with its vast network of efficient short wave stations, ever on the alert for patriotic service, and officered by men prominent in the radio art, has proposed to the Chief Signal Officer of the Army the tying in of specially selected stations of their great organization with nearby stations of the War Department and Corps Area nets. The significance of such an accomplishment can only be realized gradually. Every village, town and city in the United States would be connected by a highly organized, efficient system of radio communication, which could be interrupted by no conceivable disaster.

The recent installation of specially designed, high power vacuum tube transmitters at Fort Leavenworth, Kansas, and Fort Douglas, Utah, is of prime importance. These two stations and Washington have been provided with automatic high speed transmitting and receiving equipment. Both Washington and Fort Douglas will control the Fort Leavenworth station by automatic radio relays and will thus not only be able to communicate with each other, but with any station capable of being reached by the Fort Leavenworth station. A later article will describe this equipment and the work accomplished therewith.

While the War Department and Corps Area nets were provided for training and emergency purposes, it is obvious that any communication system so complex and far-reaching must function continuously in normal times to be able to function at all in an emergency. For this reason, and for this reason only, the War Department and Corps Area nets handle the dispatch traffic of the War Department, Veterans Bureau and the Navy, between points in the interior of the United States. Incidentally, by so doing, the government effects a net saving in telegraph funds over and above all operating expenses, except enlisted personnel, of approximately \$120,000 per annum. Finally, by extensively training many young men to operate real radio stations, it saves the Army from a repetition of that very discouraging situation along the American battle-front in France, where many such young men were needed, and few obtainable.

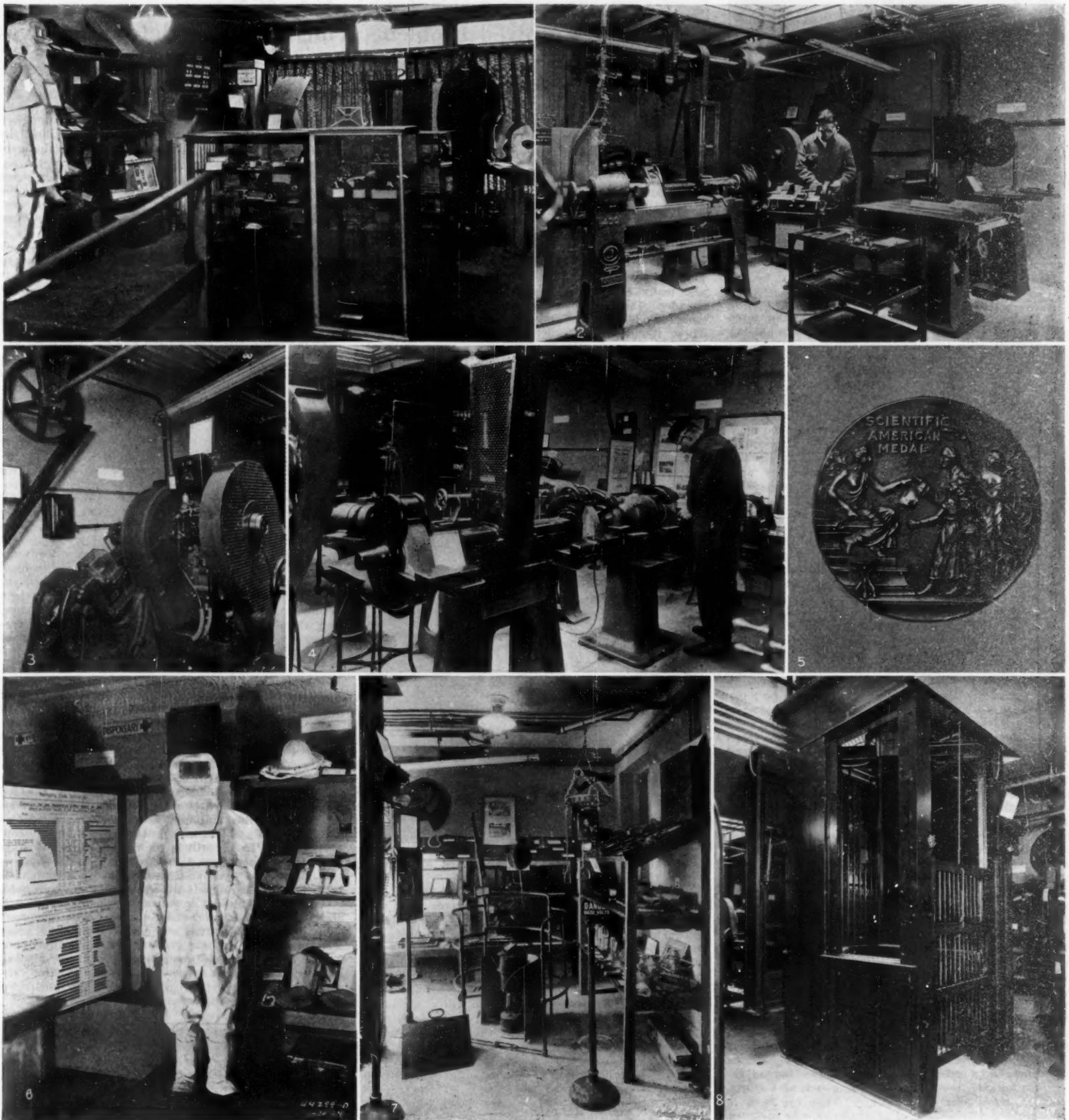
The Nature of Muscular Fatigue

NEARLY all the recent and important advances in muscle physiology have resulted from a study of the phenomena of fatigue. We all know that there is a limit to muscular exertion, a limit which is set by

what we call fatigue. If an able-bodied man take exercise at a very small rate, e.g. by walking, he remains comparatively untired for long periods; if he takes exercise more violently he becomes tired more quickly; if he exerts himself with the extreme effort of which he is capable, he is completely exhausted in less than a minute. There are many different kinds of fatigue, but the one from the study of which so much light has been shed on the nature of muscles, is the extreme athletic fatigue that results rapidly from very violent effort. By it the finest athlete in the world may be overcome within a minute.

This fatigue is a simple and comparatively intelligible thing. It can be reproduced readily in isolated muscle. For example, let an isolated frog's muscle be subjected, every second or two, to an electric shock, and its contraction be recorded. We find that the response changes in a regular and progressive way, the force exerted becoming less, the contraction developing rather more slowly and continuing much longer, and the relaxation being much drawn out. Finally, the muscle becomes inexcitable. Now in the intact animal, in man, we know that even extreme fatigue is rapidly recovered from, and this recovery is attributed to the circulation. If the circulation be hindered by a cramped position recovery is slower. If the fatigued isolated muscle be left in a chamber free of oxygen, no sign of recovery occurs; if, however, it be left in oxygen, in a few hours complete recovery will take place, and the muscle will now be capable of repeating its previous effort.

The realization, especially by Fletcher about 25 years ago, of the extreme importance of this observation led directly to the most striking advances in our knowledge of the working of muscle. Recovery from fatigue is possible only in the presence of oxygen, and it was natural to suppose that the oxygen was used to oxidize some water product, the presence of which acted unfavorably on the muscle. The next great step was due again in part to Fletcher, this time in cooperation with Hopkins. Lactic acid was known to occur in muscle, and Fletcher and Hopkins found the lactic acid to be increased by exercise, and diminished or abolished by recovery in the presence of oxygen. Furthermore, there appeared to be a certain definite maximum, beyond which the lactic acid content of the muscle could not be driven, even by the most vigorous stimulation: clearly this corresponded to the maximum effort a muscle could make.—Abstract from article by Professor A. V. Hill, F. R. S., in *Nature* for July 14, 1923.



NEW YORK has the latest safety museum. There are only three in this country, although there are many on the Continent of Europe. The new museum is operated by the American Museum of Safety in cooperation with the Department of Labor of the State of New York, and Mr. Albert A. Hopkins of the Editorial Staff of the SCIENTIFIC AMERICAN, is the Director. Exhibits may be broadly divided into two classes, namely, still exhibits, such as protective clothing, goggles, respirators, etc., and

moving machinery properly guarded. The above view 1 shows the former class of exhibit and 2 the latter. The Machine Room has all kinds of metal and woodworking machines which are demonstrated to the visitor, showing where the hazards are and how they may be corrected. The punch presses, 3, are good examples of proper guards for the actuating mechanism and at the point of operation. The "Grinder Family," 4, is not hazardous if well protected. The SCIENTIFIC AMERICAN awards a gold

medal annually for the best device recently invented and exhibited in the Museum. Our view 5 shows the face of the medal. The "Asbestos Man," 6, invites us to descend to hotter regions, but does not look very comfortable. View 7 shows how the dangers of electricity are avoided and how men can safely ascend heights by means of a boatswain's chair. View 8 is a specially constructed elevator which actually operates to show various types of interlocking door. The motor lifts the counterweights.

DEDICATED TO THE SAFETY OF LIFE AND LIMB: THE SAFETY MUSEUM IN NEW YORK CITY



A typical bank of cumulus clouds

PERHAPS the "night sky" has more persons thoroughly enchanted by its stellar interest than the "day sky." The night sky with its infinite magnitudes and numberless shining bodies not only awakens the imagination but by its infinitude provides an endless area for its play. But the day sky is full of scientific interest, of artistic charm, and also of large-scale phenomena. It is an ever-present portion of landscapes and seascapes and, expressing the mood of Nature, it provides interesting variety for those appreciative of the beautiful. But passing by this fascinating phase of the day sky, let us glimpse some of its great variety of phenomena from a scientific viewpoint.

We live at the bottom of a great ocean of air which exerts a pressure of about one ton on every square foot of earth. The liquid oceans are full of currents, great and small. Likewise great currents of air similar to the Gulf Stream flow from equator to poles and back again over fairly defined routes. Superposed on these are effects of land, sea, and season. And upon the whole is superposed a mass of eddies and convection currents depending upon the topography of the earth's surface and upon weather. In fact, the air currents might be said to be partially the cause and to some degree the effect of weather.

One of the day sky's phenomena which is usually taken for granted is the blue sky; but this aspect has commanded, even in recent years, the attention of some of our best scientists. Here we have a large scale example of the selective scattering of light by small particles. Just as the smoke from the burning end of a cigar is bluish so is the sky. But the smoke after being drawn into the mouth and exhaled is no longer blue. Moisture has condensed upon the particles, increasing their size, thus decreasing their selective scattering. So it is with fog. But the last scientific word in regard to the blue sky has not been uttered for at great heights, where dust particles and water-vapor are rare, a deep blue sky still exists. In the high regions the scattering is likely done by the molecules of gas. If so we have here an exhibition of molecular scattering of light on a tremendous scale unapproached in any experimental research devised by man. It is little wonder that science turns to the blue sky for the answers to certain questions of molecular phenomena.

Then we have the ever-changing clouds—the signposts on the highways of the winds. They make air-currents visible by their movements. They make visible the eddies and convection currents by their forms. In connection with the rise and fall of the barometer they foretell weather conditions. When long streamers of tenuous clouds spread toward the east across the sky, apparently converging at their source beyond the western horizon, they herald the approach of a storm-area if the barometer is falling. They are born in the cradle of a cyclonic area of low barometer pressure. The masses of air converge toward this "low" and the moisture-laden air is forced upward to great heights into the region of perpetual high winds. Thus they are carried far in advance of the slowly moving "low" and notify the cloud-wise that a storm-area is following them.

On a hot sultry day the sky is likely to contain thunderheads rearing their cauliflower crests into the heights. When one of these appears off toward the southeastern horizon it is something well worth watching. It is everchanging and mounting higher. The form of its crest reveals to the observer the powerful upward convection currents which stretch the great mass of cloud into the high regions of intense cold.

The Sky by Day

Solved and Unsolved Problems Which It Places Before Our Eyes

By M. Luckiesh

Director of Applied Science, Nela Research Laboratories.

Here hail is born. Here is the genesis of lightning, but how? This question is not thoroughly answered. As we watch this huge cloud mounting higher and higher many other cloud phenomena are occurring. A layer of cloud may appear at the crest owing to certain conditions of temperature and humidity. But the crest moves gradually upward through the "scarf" cloud. Finally a fragment may be torn from the crest, waving like a banner for a moment, then drifting away to be devoured by thirsty air. Such a cloud is full of scientific interest to those far enough away to view its profile. Those underneath are lashed with hail and rain and many are terror stricken by the lightning and thunder. Do we realize that we were viewing a cloud-mountain higher than any mountain on our earth? These thunderheads sometimes rear their crests ten miles above the earth.

Lesser antics of clouds are often to be seen. We lounge lazily on the beach on a warm day and watch the small fair-weather cumulus clouds drift inshore.



A fragment being torn from the crest of a huge thunderhead

When they reach a position over the shore they may be torn and pulled violently upward. Their antics demonstrate the existence of powerful upward currents rising from the heated earth which pulls the air inshore, hence the sea-breeze. Land heats and cools more rapidly than water, hence the sea-breeze by day and the land-breeze by night at certain seasons.

Then we have the chaotic sky in early spring or late fall when many kinds of clouds are present. It appears like a great stage on which properties are being rushed to and fro in preparation for the next act. High up over the horizon we may see a snow-storm. The falling snow is bright in the sunshine but its appearance may end like goat's whiskers. The thirsty air has drunk up the snow-flakes before they fell far. In another place we may see a cauliflower head rising into the sky but it will not attain the height that it would in the hotter season. Here and there throughout this chaotic sky are many secrets being revealed to the cloud-wise observer and there are many opportunities for scientific conjecture. The clouds offer numberless opportunities for exercising the analytical mind and always repay the observer with a variety of interest.

We have various optical phenomena such as the halo and the corona encircling sun or moon. The high clouds always consist of ice particles. When a sheet of these passes between us and the sun or moon, a halo of definite size, usually of 22° or 46° radius, will encircle the luminous body. The corona is formed

by diffraction of light by droplets of water in lower cloud-sheets. These optical phenomena including the rainbow offer plenty of scientific interest pertaining to refraction, diffraction, and reflection.

Along toward the latter part of the afternoon when there are plenty of clouds in the sky we often see the streamers of sunlight passing through the interstices. These huge rays of light appear fan-shaped and apparently converging toward the sun. Here is a gigantic illusion of perspective which is recognized by few as such. These rays are *parallel* and cannot be otherwise because they emerge from the sun which is practically at an infinite distance. Here is food for thought and an opportunity to surmount the illusive effect by a true mental image from which perspective has been banished.

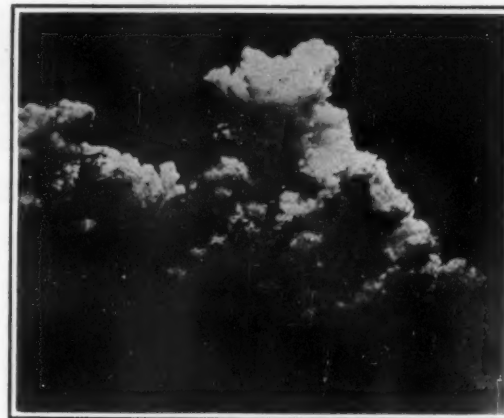
As the sun lowers toward the horizon it reddens and the variety of different colors is interesting. Various portions of the clouds receive light directly from the sun, from the blue sky, by diffusion through the cloud, and in various other ways. The effect is changing due both to the setting of the sun and to the movements of the clouds. Here is a great display of colors, the unraveling of which into the components of the mixture is sufficient to satisfy the most analytical mind.

After the sun has set, the progressive color-scheme is still visible if clouds are present at various altitudes. If we could view the beam of direct sunlight in profile we would see the lower portion red, the next higher orange, the next yellow and so on. As the minutes pass by we see any given cloud colored in the reverse order until finally the highest wispy cirrus clouds are bathed in red light—the last lingering rays—about twenty minutes after the sun has set for us on the earth. Here are geometrical problems of much interest.

Once in Iowa during an unusual period of dryness and absence of clouds great shadows passed across the sky which persisted for an hour or so after the sun had set. Not a cloud appeared in the sky for eight days and each evening these shadows appeared. The same cloudless period was reported in the states to the westward and across eight hundred miles of prairie to the Rocky Mountains there is no great body of water over which clouds might hover. These shadows were fascinating as they appeared each night after a cloudless day. How were they formed? Could they be the shadows of the Rockies nearly one thousand miles to the westward! The application of geometry to the approximate distance and altitude of the Rockies, indicated that the sun's rays passing over the crests of the mountains and tangent to the prairie east of the mountains, passed over Iowa at a height of about sixty miles. This is still in the region of air and other particles and therefore it is possible that the shadows of the Rockies were seen nearly one thousand miles away! The day sky is always presenting questions.

As the sky fades after sunset the last flush of daylight disappears when the sun has set for an imaginary individual at an altitude of about one hundred miles. The duration of twilight gives a direct measure of the height at which atmospheric gases exist in sufficient quantity to reflect an appreciable amount of light. The twilight limit is far above the beginning of the region

(Continued on page 438)



A thunderhead five miles high

New Ideas of Prehistoric Flora

FORMERLY geologic time was measured in millions, later in hundreds of millions of years; now it may have to be reckoned in thousands of millions of years. This revision of ideas has been suggested by the discovery that flowering plants which had been supposed to be relatively modern grew way back in the coal age. A "coal ball" discovered by Dr. A. C. Noé, paleobotanist of the University of Chicago, in research work in American coal fields has brought this startling fact to light.

Coal balls are round limestone balls varying in size from a walnut to a coconut. They are found in coal beds and contain perfectly preserved plants, fossils of the same kind of plants which formed the immense coal fields of the world. If these balls are cut with a power saw into small blocks and these in turn are sliced to thin sections with a diamond saw and then reduced to minute thinness by grinding, they reveal under the microscope the plant cells, fibers and organs in exactly the same forms as if they were still alive.

Coal balls were found as long ago as 1835 in England and northern France, and it is on the microscopic study of these by European scholars that the entire knowledge of the vegetation of the coal age of the world's evolution is based.

It was not until 1922 when Dr. Noé discovered coal



Banyan tree of unusual proportions, at Palm Beach

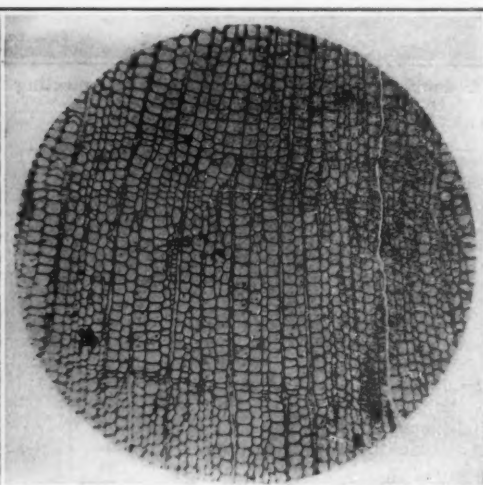
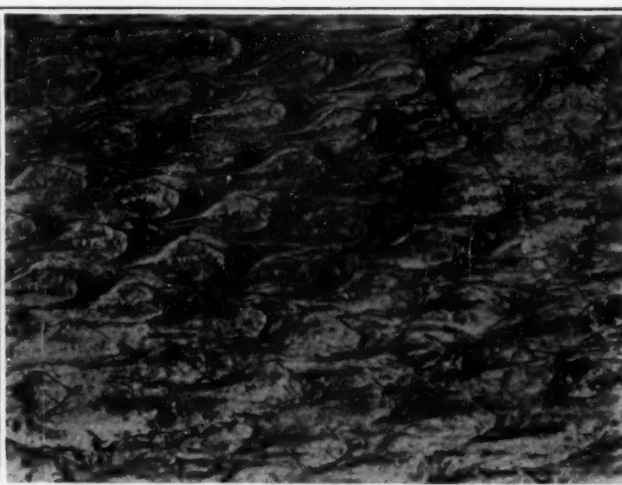
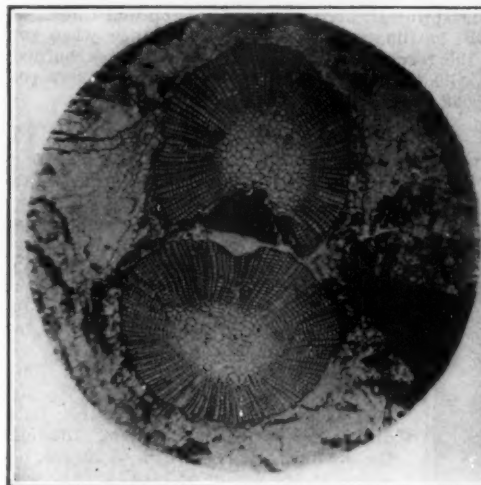
It seems fairly obvious that these immense spreading branches, extending for many yards from the parent trunk without any of the gradual reduction in sectional size which usually is noted under parallel circumstances, would not support their own weight if this

The Origin of Petroleum

UNLIKE most problems concerning origins, that of the genesis of petroleum has a distinctly practical significance, for if solved, prospectors for mineral oil would be provided with important data and chemists might learn how to produce artificially valuable substances similar to, if not identical with, natural petroleum. Explanations that affirm a cosmic origin or postulate volcanic activity as the effective cause, have long been abandoned, and today there are only three which find scientific support. The least popular of these, the inorganic theory, affirms that petroleum originates from the interaction of metallic carbides, presumed to exist immediately below the earth's outer crust, and steam, whereby various hydrocarbons are formed, which then undergo further changes.

The views that are uppermost today are that petroleum is derived from either animal or vegetable substances, or from both of these sources, and the chief direct evidence supporting this organic theory is the occurrence in petroliferous strata of vegetable and animal remains, including, in a few cases, remains of bacteria. The various elaborations of this view are mainly concerned with the nature of the chemical reactions involved, and how they are influenced by the three determining factors of pressure, temperature and time.

The evidence admitted by those who believe in a



Left: Section of the divided stem of a coal-age tree, found in a coal ball. Center: Tree-bark from the coal age, which has come down to us preserved in a coal ball. Right: Section of wood from a tree of the coal age, 50 times magnified. Since there were no seasons in those days, only an eternal spring, the seasonal rings of present-day trees are missing

What the coal-ball fossils tell us of the vegetation of the days in which the carboniferous strata were laid down

balls in coal seams in Illinois and Kentucky that any had been found in America. They have since been discovered in Texas and Dr. Noé has found them in Indiana and Iowa. One collected in Illinois has revealed under the microscope the stem of a highly developed seed plant similar to a cornstalk.

All previous study of coal balls had given the information that plant life of the coal era was of a low order, consisting of ferns, club mosses and plants of the horsetail family, which in an atmosphere saturated with vapor grew to the size of immense trees. No seasonal rings such as are found in modern woods have been discovered in the fossil remains, giving proof that it was eternal summer those days or better, in view of the humidity, eternal spring.

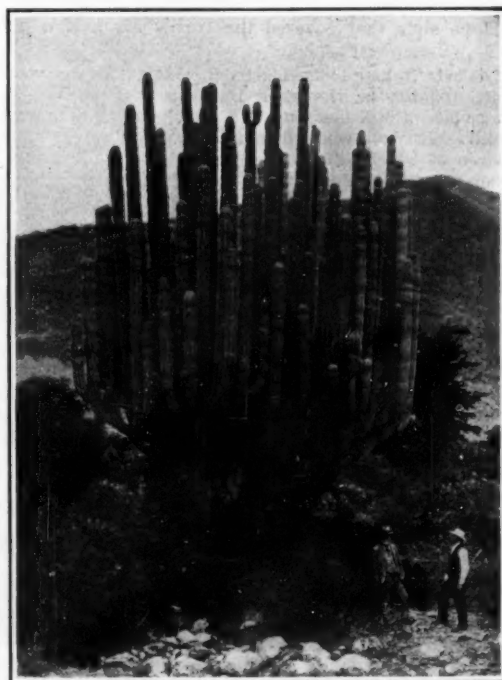
From the knowledge of coal plants and the conditions under which they grew acquired by study of coal balls, scientists have been able to reconstruct ideal landscapes picturing the world as it must have been in the age when coal was formed. The discovery now of a highly developed flowering plant in an American coal ball indicates that other forms of life should variegate the landscape. But mostly it upsets all previous conception of the age of the world.

"Over a thousand million years must have elapsed," says Dr. Noé, "between the origin of plant life on earth and the stage of evolution reached at the time when the coal was laid down. The time since the coal age is now figured as several hundred millions of years. The existence of highest forms of plant life in the coal age shows that the time which elapsed between the origin of plants and the coal age must have been much longer, probably ten times as long as the period since the coal age.

A Tree with Engineering Judgment

IN our school days we were taught that the banyan tree sends down shoots from its limbs which take root in the ground; but we do not recall that anybody ever attempted to tell us why this was done. The picture adjoining will perhaps lend a suggestion here.

were all to be thrown upon the limbs themselves. It looks very much as though at least one of the functions of these very sturdy secondary root-stalks were to act as props. In other words, the banyan tree must be cited as another demonstration of Dame Nature's engineering instinct.



One of Mexico's prize cacti

purely animal origin includes the statements: that petroleum found in primary rocks is much more often accompanied by animal than by vegetable remains; that formations containing only plants are not bituminous; that mixtures of hydrocarbons similar to those found in petroleum can be made artificially from animal fats, and that such production can be observed in Nature today, notably in the coral reefs and lagoons of Djebel Zeit in Egypt. The scarcity of animal fossils in petroliferous strata is explained by assuming that the fauna were either skeletonless, or, if not, that their calcareous coatings were dissolved by the carbon dioxide liberated during their decomposition. Advocates of the vegetable origin doubt if the supply of animal matter has been sufficient for the purpose; they comment on the absence of phosphatic deposits from the vicinity of oilfields; and they trace relationships between coals and petroleum.

Supporters of the vegetable theory maintain that geological evidence is accumulating in support of the view that coals and lignites are related to petroleum. Thus, in numerous cases, the main oil-bearing horizons have each a carbonaceous phase in some other district, and the petroliferous and carbonaceous phases approach each other very closely in some localities.

A Giant Cactus

THAT tropical vegetation grows far more luxuriantly and to far greater size than that of temperate zones is a truism; but perhaps an illustration of the fact will not be out of place. For such purpose we can use nothing to better advantage than the accompanying picture of an organ cactus that is to be found along the railroad line south of Mexico City. No statement of its size accompanies the print which reaches us, but the men in the foreground will afford the inquisitive reader the raw material for a rough scaling off which will demonstrate that the huge spine bush is at least 25 feet high. The specimen in question has attained considerable local fame, and is spoken of by the cameraman as one of the most picturesque in the world.

Snowslides

Some Facts about Their Menace and Their Prevention

By D. S. Olson

Chief of Planting, United States Forest Service



A double slide in the Coeur d'Alenes, meeting at the bottom

THOSE who have toured the Yellowstone Trail between Spokane and Missoula remember a desolate stretch of dead forest—mile for mile, as far as the eye can see; a million acres, a billion bleached and blackened trees, monuments of once living virgin timber. The old story—a forest fire.

There's another picture in the winter time of the same mountains—a winter scene, more desolate. No green mat on the hillside, no shrubs along the road and banks of streams. Only the forest of "telephone poles," standing like sentinels in the mantle of snow on the bleak mountain slopes. And in that country in the winter time this condition brings a menace to lives and property—snowslides.

The reader is aware of the importance of tree growth and other vegetation on steep slopes in holding the soil directly by a fine network of interlacing roots, and indirectly by retaining moisture in the spongy mat of roots and leaves, thus overcoming the danger of erosion from spring freshets. In a like manner the forests protect the slopes from snowslides.

For ages snowslides have occurred but in this country their menace has not been felt until in late years. Public lives and property are the toll. Railroads particularly are endangered when the snow begins to slip.

Railroads have suffered heavy losses in this region from snowslides, and the impressive fact is that conditions on this 1910 burn will not improve in the near future but become worse, because the standing dead timber is gradually rotting and falling to the ground. Standing trees, living or dead, if sufficiently dense hold the mantle of snow on the ground from sliding even on the steepest slopes, just as nails hold shingles in position on a roof. Remove those nails and friction would be the only force that would hold them in place. Start a few shingles at the top to sliding by a jar, or pour water on them, and the result would be an avalanche of shingles. When the trees are removed and friction between the crust of snow and the soil is reduced you have an avalanche of snow.

When a heavy mantle of snow has become charged with water on steep treeless slopes a snowslide may be expected to occur at any time. The rain aside from adding more weight to the snow causes it to become more mobile. Also the water seeping through the porous snow acts as a lubricant on the more impervious soil and causes a slipping plane. Then something lends an impetus and, aided by gravity, the avalanche starts on its course of destruction.

When conditions are just right any number of things may start the movement of snow. Masses of snow losing their poise on precipitous rocky cliffs may give the necessary impetus. A falling tree may cause a slide. The vibration of a passing train, no doubt, causes many. In Switzerland it has been noted that

the detonation from a gun has been sufficient to start a slide. A small stone or lump of snow may fall from its perch and start rolling down the slope, increasing in size as it picks up more snow at every revolution until in one of its great bounding leaps it crashes down, and, with its momentum and added weight, pushes everything before it.

There are two types of snowslides, those confined to narrow canyons, and those occurring on broad slopes. The former is by far the more destructive, and once a slide has occurred in a canyon, slides will continue to occur there because the first slide takes all debris that under less favorable conditions would offer obstacles to the phenomenon. After the first slide, the canyon becomes a veritable chute for future slides. Railroads protect themselves from such slides by constructing snowsheds over their tracks, the train passing under the protection of the shed and the avalanche passing over the roof, on down through its course. The cost of such protection is exceedingly high.

The location of a new canyon slide cannot always be predicted and it is the first slide which is the most difficult to clear away because in it the snow is mixed with stumps, trees, boulders, and other debris which make the mass almost impossible to cut through.

A year ago such a slide occurred on one of the transcontinental lines and shut off traffic on that road for a week. This slide covered the track to a depth of more than 50 feet, and because of the tangled mass

slopes being logged is important to insure sufficient trees remaining to hold the snow.

Once a steep mountain slope has become denuded of tree growth the cure for snowslides is expensive because recovery is slow. The areas must be planted to trees, and perhaps in places replanted several times, for slides may occur in places before those trees are 15 years old—old enough to hold back the snow.

The snowshed is a protection measure against canyon slides, but not a cure. As the paths of those slides become better scoured the slides become more frequent. The paths of those slides are often a mile long. To establish tree growth on such places the work must be started at the top, planting a little every ten years or so until the bottom has been reached. The principle involved here is that sufficient trees of sufficient size must be established above to hold the snow from sliding on the next strip to be planted below.

Next spring if your train is late stop and think. It may be battling with a slide. This summer when you tour the forests look long at those big black burned-over hills, then enjoy the green ones—and, be sure you put your campfire out.

Is Snowfall Decreasing?

A RECENT number of the *Monthly Weather Review*, published by the U. S. Department of Agriculture, contains an article entitled "Are we having less snowfall?" by Mr. C. J. Root, of the Weather Bureau at Springfield, Ill. Snowfall in the State of Illinois is chiefly considered, but for completeness the author has discussed what has happened in other States. The inquiry is suggested by such remarks, as "We do not have the big snows that we did when I was a boy, and I do not think we will ever have them again." At Springfield the snowfall has been rather light during several recent winters, although the greatest fall on record, 43 inches, occurred in the winter of 1913-14. The winter totals averaged for periods of ten years from 1884 are 20.3, 19.6, 21.9 and 20.3 inches. In New England the snowfall was unusually heavy in the winter of 1922-23; at Portland the January fall was 53 inches, and in the winter the total exceeded ten feet. All highways are said to have been absolutely impassable for automobiles from the first week in January until the last week in March. At Albany and New York the snowiest winter occurred some 30 years ago, while at New Haven, with a record from 1873, the heaviest snow occurred in the winter of 1915-16, and in 1922-23 the total was 19 inches above the normal. Many more facts are given, and the author sums up with the conclusion that in years to come the snowfall will be as heavy as in the past.

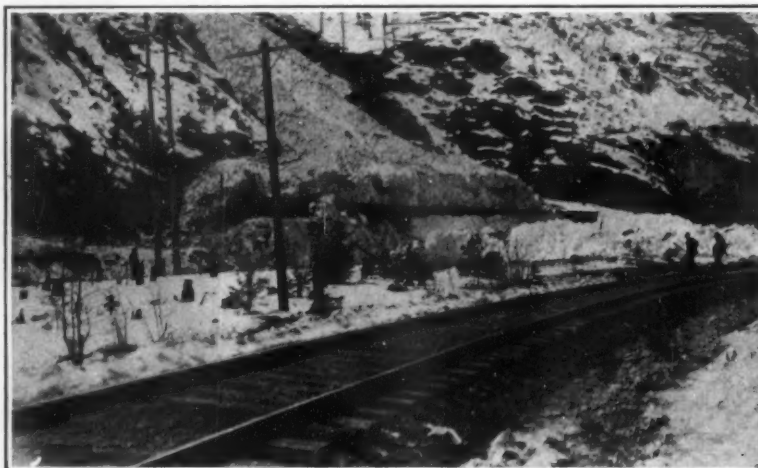


A slope slide that covered the tracks for half a mile

of debris it had to be blasted through. As the snow melted later in the year the logs left as residue resembled a mill log pond. In the spring of 1922 fourteen slides were counted in a distance of seven miles, eleven of which reached the tracks and covered them to a depth of from 6 to 50 feet.

Slope slides are less difficult to clear away because they travel a shorter distance and consequently are not so deep or carry as much debris. These are less dangerous than the canyon slides, but because they cover wide areas and do not have well defined paths or occur the same place every year they cannot be economically overcome with snowshed protection.

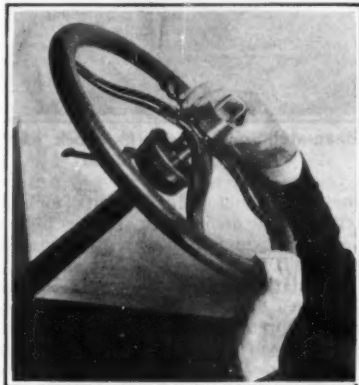
The remedy for both classes of slides is the "ounce of prevention." Forest fires burn up the trees—the pegs—that hold the mantle of snow in place while the spring sun gradually melts it down. Careful selection of trees to be cut on steep



Snowshed protecting a railroad. The track under the shed, which is entirely out of sight in this view, would be covered with snow if it were exposed; in fact, it is as clear as the one in the open foreground

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News



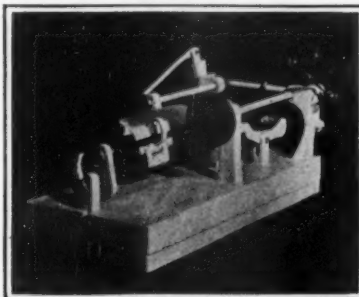
Padlock that uses a combination in place of a key

The Keyless Padlock

THE application to the automobile steering wheel which we illustrate is but one of the fields in which the keyless padlock, invented by S. B. Sklar of Memphis, is available. It has the external form of the ordinary padlock, save that the clevis enters a cylinder instead of a flat member as in the usual case. This cylinder is built up of six disks, each turning upon their common central axis, and each carrying numbers from 0 to 9 around its edge. When the disks are spun to set up the proper combination, the clevis is released and may be withdrawn. The user, according to the inventor's theory, is less likely to forget the combination than to lose the key; besides, the physical inconvenience of carrying the key is eliminated.

Something New for Setting the Table

ACCOMMODATING the four pieces of silver most freely used at table—knife, fork, spoon and teaspoon—the contrivance illustrated herewith is offered as a means of speeding up and systematizing the setting of the table, as well as giving the finished set a neater appearance than it ordinarily presents. The metal tray is three inches wide by four long. With the wire rack erect, in position to receive its load of eating tools, the height is $2\frac{3}{4}$ inches; but the rack is detachable and may be laid flat upon the tray, thus minimizing the storage space taken up by the outfit between meals. In addition to the four pieces mentioned, the "servisette" will in a pinch accommodate several other items—butter spreader, salad fork, etc. It affords a place other than the plate and the table cloth whereon to lay these tools during pauses in their use or when one is through with them. The tray of the servisette is also of much use as



Sharpening the knife on both sides

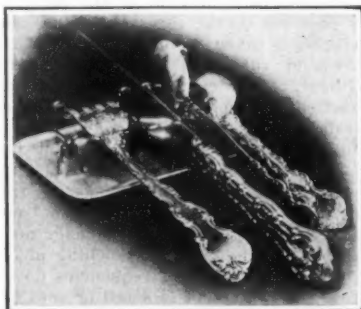
a place to deposit fruit seeds, pits, peelings, nutshells, cigar ashes, etc., etc. We must confess to having more than once been embarrassed by the absence of a place to put such refuse. When we were younger, we used to hide it under the table, on the little ledge in which the extension runner slides; but in manhood's estate we have felt constrained to abandon this system, and the servissette would be a welcome substitute.

Soft Drinks While You Wait

SOMETHING quite novel in the way of liquid refreshment for the weary traveler is offered, in the paper-cup assembly illustrated. The two cups are originally purchased, nested together, as shown in the center figure of our photograph; and in the bottom of the outer member of this assembly, beneath the packing of tissue paper which holds it in, is a quantity of powdered flavoring. One takes the cups apart from one another, fills the empty one with cold water, and pours this back and forth several times to mix it with the flavoring matter. One then has a perfectly good cold drink, of whatever flavor one has originally selected—the outer container being plainly marked to identify this. For use on trains, automobiles, boats, etc., this system has obvious advantages over one that involves the carrying of soft drinks in fluid form.

A Novel Knife Sharpener

THIS device is designed to sharpen or grind knives or cutlery, and may be operated either by hand or motor power. It consists of a cradle, adjustable for both length and width of the blade, on which is mounted a vise, the knife being held therein by a set screw. On opposite sides of the cradle abrasive wheels are placed. As the cradle moves



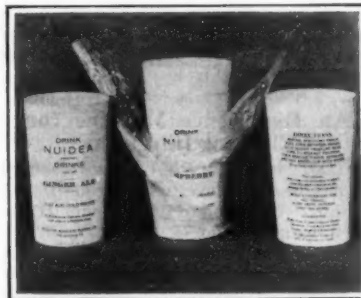
Cutlery tray that adds to the unity of the set table

in one direction one side of the blade is brought in contact with the abrasive surface. A reverse movement of the cradle brings the other edge of the knife against the revolving abrasive wheel. By means of such rocking and reciprocating motions a cutting edge is quickly and automatically given to the full length of the cutting surface.

Dispersing Rubber in Water

ANOTHER epoch-making invention has just been announced, the discoverer being a rubber technologist, Mr. William B. Pratt; and, strange to say, the first knowledge of it came from the disclosure in an Italian patent. The process is extremely simple and consists in kneading crude rubber in water in the presence of soap bark with glue as an

assisting agent. As is well known, pure, unvulcanized rubber can be rendered viscous by benzole or other similar solvent, so that it can be used for coating or cementing. Such solvents are very inflammable and have resulted in many explosions and fires. Furthermore, the solvent is also lost. Benzol poisoning is such a menace that the National Safety Council appointed a special committee to examine the evidence, and the bibliography on the subject alone occupies seven pages of their report. Attempts have been made to reduce the danger by working in closed cabinets where there is a surplus of air, the volume of which is so great that all danger of explosion or fire is eliminated. This plan, however, does not make for economical production. It is for this reason that a water solvent is interesting to rubber manufacturers.



Soft drinks in package form—add cold water and serve

The equipment required is only an ordinary dough mixer which can be set almost anywhere in the plant, and as there is no danger of fire it can be set running and left alone. The rubber in its crude form, either "pale crepe" or "smoked sheet," is introduced into a mixing mill and the power is started. The rubber soon becomes warm, when about 5 per cent of glue is added in either dry form as a paste made by heating the glue with a small quantity of water. Up to this point we have a rubber-glue mixture thoroughly incorporated. The mass is now transferred to a suitable mixer like a two-blade dough mixer. About 10 per cent of water is added and the mixer is started and is kept in operation until all the water is absorbed. A heated solution of saponin (soap bark) is added slowly and the entire mass is gradually diluted with hot water. The mixing is continued until a smooth paste is produced in which the rubber has been dispersed into small globules. Rubber compounds, such as fillers, etc., may be treated in the same way. The dispersed rubber may be vulcanized if desired, the process not impairing any of the possibilities of vulcanization.

The dispersed rubber can be spread upon fabrics and the cloth used for the manufacture of hose, raincoats, tires, vehicle tops, etc. It can be used in the place of volatile solvents for cements, for special vulcanized paper, in the production of artificial leather, in tree surgery, as a binder for building and flooring materials, and last, but not least, in chewing gum manufacture. Further experiments will probably develop new fields of usefulness so in a short time we have had two radical additions to the technology of rubber: "latex" and "dispersed rubbers."



Phonograph attachment that enables the deaf to use this instrument

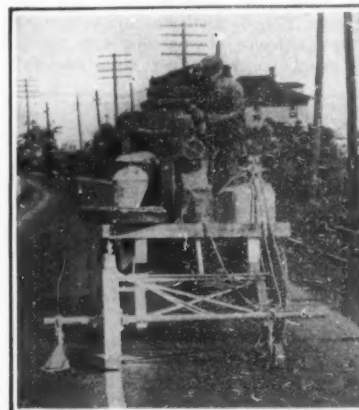
The Deaf Man's Phonograph

WITH the aid of the "dentiphone," invented by J. W. Gonce, of Anderson, Tenn., the pleasures of the phonograph are extended to the hard of hearing. The picture is largely self-explanatory; as it indicates, one end of the attachment carries the stylus which rests in the groove of the phonograph record, while the other is formed into a mouthpiece to be held between the user's teeth. The tones of the record then become audible to him, through the vibrations of the bones of the head which are set up—quite as many deaf people are enabled to hear ordinary conversation through an instrument that brings about such vibration.

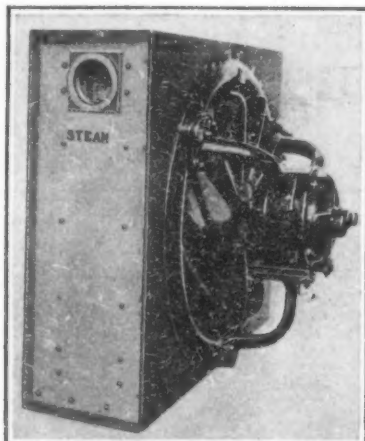
Mr. Gonce tells us that the device may be constructed from any suitable resonant material, such as steel, hard rubber, or numerous woods. While a stylus or needle of metal is desirable, favorable results have been obtained with styli of hard wood. The inventor does not confine himself to the form or cross section illustrated. There must of course be a head of some sort to carry the stylus, and at the other end a suitable mouth-piece; and near each end there must be a thin, flexible section—the one near the stylus helps the latter to follow the groove in the record, while the one near the mouth-piece is necessary to avoid shock and jar to the teeth. Between the two thin sections, the instrument may be of practically any cross-sectional figure whatever.

The White Stripe on the Road-Center

FOR painting a white stripe down the middle of the concrete highways in Wayne County, Michigan, a pneumatic spray-painting machine has been devised.



Marking the center of a Michigan highway



Steam-coil heater that multiplies by five the efficiency of the ordinary outfit of the sort

which is most practical in operation and has reduced the cost of this work materially. Under the old method four painters could stencil about one mile a day. With this machine two men can cover six to seven miles per day.

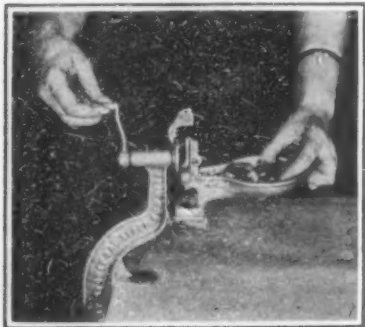
The equipment consists of a compressed-air paint-spraying machine that is mounted on skids and is bolted to the floor of a truck. A wooden wheel two feet in diameter, four inches wide and covered with a strip of felt one inch thick, revolves on an axle that is part of an iron frame attached to the rear of the truck. The wheel is so placed that it follows in the track of the left-hand wheels of the truck. As the truck is driven ahead, the paint is sprayed directly on to the felt, and as the wheel trails after the truck the paint is immediately transferred to the pavement. Chalking the middle of the highway helps the driver in centering the stripe.

A Guard for the Button Polisher

OUR buttons do not need to be cleaned as a usual thing but if you wore a uniform bearing brass buttons, it would be different. And the uniform is very apt to be soiled during the cleaning operation. This is obviated by an inventor's clever device by which the button is held away from the cloth by a tin shield so that the cleaning material may be applied to the button without any danger of getting on the cloth. The holder is adjustable to any size of button. And if it is desired to polish the button, it can be done with what is known as the "polishing mit" which consists of a number of pieces of chamois attached to a back. This affords a useful chamois cleaner.

Stoning Cherries by Machine

EVERYBODY knows how disagreeable it is to get a piece of cherry pie when the cherries have not been pitted. This is entirely unnecessary as a most efficient cherry stoner is now on the market. A plunger rises and falls



Getting all the stones out of all the cherries, by machine

and cuts the cherry so that the stone is forced out. This is interesting to bakers and restaurants and would be very useful in the kitchen of the average house or apartment.

Steam Heat Without Radiator Troubles

MUCH the same constructional principle as that of the "copper-cooled car" is seen in the heater unit illustrated herewith. The steam coils in this heater are of copper and brass to begin with, both offering far less resistance to the transmission of heat than does iron. And on top of this, these tubes are of straight, seamless copper and brass tubing; while around them is helically wound a copper ribbon in such fashion as to form a continuous fin. This fin is not actually welded to the tube, as the copper fins of the "copper-cooled" car are to the iron cylinder casting; but it is bent in such a way that a large surface of the fin is in contact with the outer surface of the tube, and this union is brazed. This insures easy passage of heat from the tube to the fin and from the fin to the air that passes through the heater. The heater unit itself, shown externally in our picture, is mounted at strategic points in large or small rooms, throughout factory and warehouse buildings, etc. The fan has a capacity of approximately 3,000 feet of air per minute; and this air issues from the unit thoroughly heated.

An Experience Machine for Elevator Interlocks

THAT "experience is the best teacher" has been a proverb from time immemorial. Unfortunately it takes time, often long periods of time to gain experience that is of real value. One of the greatest drawbacks in the rapid development of mechanical devices is the length of time necessary to determine its merits or short-comings. Automobile manufacturers test new engine types and



Polishing the button without soiling the uniform

other automotive innovations for months or even years before the device is placed on the market. Sometimes machines in charge of picked crews are run day and night over rough roads in order to expedite the task of obtaining this needed experience.

When the City of Baltimore recently revised its elevator code it took a step forward by requiring all hoistway door interlocks to pass rigid engineering tests before being approved. Arrangements were made with the U. S. Bureau of Standards to conduct these tests.

As a safety device of this kind should provide several years of trouble-proof service it was desirable to obtain the same wear that would normally develop during a period of years within as short a space of time as possible. At the same time it was obviously undesirable to operate the device faster than it would be operated in regular service.

After a considerable study of the various factors involved a machine was developed and put in operation which duplicates the performance of the elevator operator, and in addition tests the door

and car control when they are presumably locked. Failures are recorded both electrically and on a mechanical counter.

By an ingenious arrangement of parts it is possible to run two tests simultaneously, one in an enclosed hoistway (dust test or corrosion test) and one in the open hoistway (life function or lack of lubricant).

In addition to operating the hoistway door and the car controller it was necessary to devise mechanisms which would operate foot pedals, lift latches, pull down on bar lock handles and give the same sweeping pull on the handle of door closer type devices that the operator would. These and similar engineering problems were successfully met and the machine can take care of practically any type of device on the market.

The testing machine is also arranged so that the range of movement of both platform and hoistway door through which a given device will operate can be accurately ascertained.

The City of Baltimore has already published a list of seven devices which have met these tests.



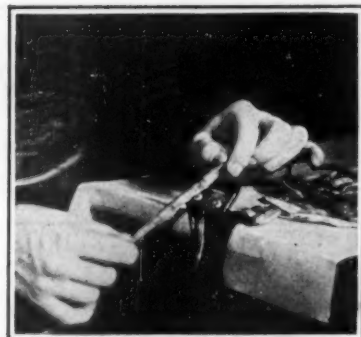
The padlock that thrives on rough treatment

Auditory Masking of Pure Tones

USING an air damped telephone receiver supplied with current with a proper combination of two frequencies, as source, the amount of masking by tones of frequency 200 to 3500 was determined by R. L. Wegel and C. E. Lane for frequencies from 150 to 5000 per second. The magnitude of a tone is taken as the logarithm of the ratio of its pressure to the threshold value, and masking is taken as the logarithm of its threshold value with masking to that without. The curves of masking as function of magnitude are approximated straight lines as a rule except for rounded feet, of slope s intersecting the magnitude axis at minimum masking magnitude m . For a given masking frequency n the slope increases from zero through nearly 1.0 for a frequency near n , then more slowly, approaching about 3 to 4 for the highest frequencies measured. The intercept is small or zero below n , then increases rapidly, approaching the value 3 for the higher frequencies.

Except when the frequencies are so close together as to produce beats, the masking is greatest for tones nearly alike. When the masking tone is loud it masks tones of higher frequency better than those of frequency lower than itself. When the masking tone is weak, there is little difference. If the masking tone is introduced into the opposite ear, no appreciable masking occurs until the intensity is sufficient to reach the listening ear through the bones of the head. At intensities considerably above minimum audibility, there is no longer a linear relation between the sound pressure and the response of the ear. Data are given showing combinational tones resulting from this non-linearity when two tones are simultaneously introduced in the same ear.

The presence also of subjective over-



Bean-stringer that works much like the carpenter's plane

tones in a loud tone accounts for the large amount of masking of tones higher than itself which is observed in the case of a loud masking tone.

The data on masking together with Knudson's data on frequency sensibility are interpreted in terms of the dynamical theory of the cochlea which ascribes its frequency selectivity to passing of vibrations along the basilar membrane and a shunting through narrow regions of the membrane at points depending on the frequency. Conjectured curves are given for a few single frequencies of the amplitude of vibration of this membrane as a function of the distance along it.

A Different Padlock

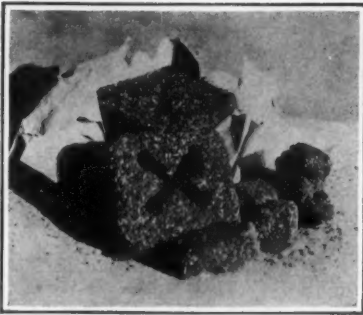
THE special construction of this padlock makes it particularly theft proof. A patented bolt is used to lock securely together the two solid pieces of steel which make up the lock. This bolt is inserted in the steel casing of the lock and it is claimed that it cannot be picked or broken. The lock can be left open by turning the shackle around and inserting the bolt through the end remaining in the casing.

Cutting and Stringing Beans

EVIDENTLY no inventor has ever devised a machine which will take out the strings and cut the beans into proper lengths at the same time. But the two devices which we show for doing these things separately are very simple. In a stringer, a knife like a plane iron is set in an iron frame and the bean is drawn over the knife. The objectionable portion of the bean, namely, the string, is eliminated. The cutter consists of a disk having knives which cut the beans into proper lengths as they are forced through the channels in the casing. The speed of this machine is very great, thus making it very valuable in restaurants and hotels.



Companion piece to the bean stringer shown above, cutting the beans into uniform lengths



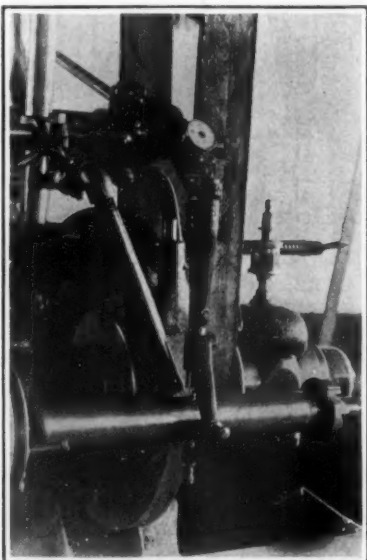
The newest thing in kindling material, fresh from France

Kindling Fires with Sawdust Cake

THE curiously figured cakes seen in the photograph at the upper left corner of the page are not the latest health food from Battle Creek, but rather a Scotch fire-lighter—at least, their trade name is Scotch fire-lighter, though they are made and used in France and imported to this country only from France. They are of a sawdust conglomerate, held together with some unidentified binder. They serve the purpose to which yesterday's newspaper is ordinarily put in this country—kindling the wood that is to kindle the coal. Though easily crumbled and broken into smaller pieces as our picture indicates, the importer assures us that the lighters are designed to be used whole. They are set up on edge, several in a row, and the wood laid across them. They will take fire at any point on their surface, from a match, and will burn vigorously for a considerably longer period than ordinary paper kindling—though not long enough to ignite wet wood. The fancy hole in the center of the lighter cake is for the purpose of introducing air to promote combustion.

Gaging Work While It Is Being Ground

SO that work will not need to be stopped for the use of a snap gage or micrometer, a grinding gage has been developed which measures work while it is being ground. The gage consists of a body in which a plunger and a plunger spring are housed and on which the indicator is mounted. Each gage contains three diamonds, two of which are mounted in the ends of adjustable screws and one is mounted in the end of an automatic spring-actuated stylus or plunger. A spring pressure of less than one ounce will keep the diamond



Gaging on the fly, without stopping the machine

points in contact with the surface being ground, penetrating the grinding fluid and giving true measurements. While the grinding proceeds the dial of the gage gives visible readings of the diameter.

That Hermetically Sealed Window

A FRAIL old lady vainly wrestling with a Pullman car window in an attempt to open it. A genial Tarzan of a man, confidently offering to open it for her. One genial Tarzan of a man, now redfaced and puffing, embarrassedly retreating after having completely disarranged the ready bedding of a very particular old lady, without having budged the sticky window one umpteenth of an inch. The fact is, according to *Pullman News*, a special organ of the Pullman Company, the windows of Pullman cars are purposely made hard to open in order to cut down to the minimum all chances for drafts and dust. This, says that periodical, is why passen-



A sure-fire opener for jammed railway-car windows

gers sometimes say naughty words when they essay the task, rather than call the porter. But the Pullman cars are now being equipped with a special device consisting of a lever with a sliding, hinged fulcrum. By means of this lever the most obstinate window can be started without the necessity of crawling into the berth or even of working one's self into a fit of anger.

A New Technique in Making Hash

WE are not apt to associate hash with France but the latest improved chopping bowl comes from that country. It consists of a wooden bowl with a knife of the same curvature as the bowl. Before chopping, the food is cut in small pieces and the knife may be used for this purpose. When you wish to do fine chopping, the blade is pressed slowly on the bottom and in the center of the bowl. The wrist is then moved to and fro so that the blade describes part of a circle. After each motion, the wooden bowl is slowly turned. The hachinette is extremely valuable in mincing vegetables.

A Roller Skate That Works Like an Ice Skate

THOSE of us whose memories carry us as far back as the last two or three years of the nineteenth century will perhaps remember the bicycle-skate, and the craze which accompanied its introduction and lasted for some months. For those of us who don't remember it, it may be explained as a roller skate with two rubber-tired wheels, mounted in tandem one behind the other, centrally beneath the foot. It gave a thrill which the older, four-wheeled skate never possessed, but for some reason it never really caught on.

A fresh attempt is now being made to put the roller skate upon a new basis. This time we are offered a skate with three wheels, but they are mounted all in line, and not in tricycle fashion as

one might infer from a mere statement of their number. The inventor is Mr. M. Metcalf, of London. The real trick to these skates is found in the central wheel. This is a trifle larger than the other two, lending the arc effect of the ordinary ice-skate blade. The skate is very light—15 ounces for the gentleman's model and 12½ ounces for the lady's.

Color Photographs of Microscopic Plants

THAT color photographs of microscopic plants can be taken by the light emitted by the plants themselves after stimulation by a strong beam of light was shown before the American Association for the Advancement of Science on December 29, by Professor Francis E. Lloyd, of McGill University.

Plants contain a considerable number of pigments which have the property of fluorescence, a property due to the ability of the pigment to change the wave length of the blue-white part of the spectrum into the longer wave lengths, green, orange and red. In the case of green pigments, the result of this property is to produce red light even though no red light is supplied.

The attempt has often been made by various workers to see fluorescence in living microscopic plants by means of the microscope, making use of a special optical arrangement known as the dark field illuminator. The lack of success following these attempts led to the conclusion that this was not possible. Indeed, the only way in which fluorescence has been seen microscopically in the living organism is by means of a very special optical arrangement known as the fluorescence microscope, or one in which only ultra-violet light is permitted as an illuminant. Since the visibility is low, no structures can be seen, nor can high magnification be successfully used.

Professor Lloyd described a method of his own invention whereby the dark field illuminator can be so adjusted as to pro-



The hash-knife that fits the curve of the bowl

ject a strong beam of light upon microscopic organisms in such a way as to bring out a brilliant fluorescence and also reveal their structure. When viewed by this method microscopic plants were seen to glow in brilliant hues of red, orange or yellow. Preparations of living plants were exhibited in which this was visible to the audience. Color photographs were also shown.

The importance of this discovery lies in the fact that it affords a new method of studying in plants the pigments which are connected with the process of photosynthesis, or the building up of tissue from the carbon, hydrogen and oxygen of air and water through the action of light. Evidence is increasing that other pigments beside the green chlorophyll are of importance in this way. Already structural relations have been demonstrated which were previously not understood.—*Abstract from Science for January 4, 1924.*



The roller skate that runs like an ice skate

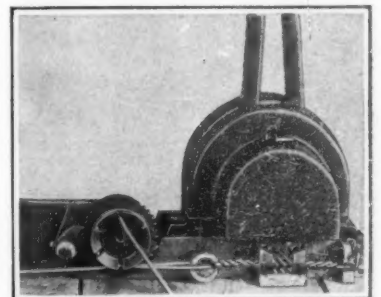
An Ingenious Wire-Tying Machine

A WIRE-tied box is about twice as strong as the ordinary nailed box if the wires are properly applied. Such boxes, when used for the shipment of merchandise, are greatly protected against pilferage simply because pilferers prefer to attack the comparatively unprotected package rather than one on which a tied wire has been broken and which is readily detected while in transit, fixing the liability on the carrier in whose hands it happens to be. Further, a wire-tied package permits equal strength with less thickness of lumber.

The new wire-tying machine which is illustrated on this page is for tying wire on the package, not for making hoops to be placed around it later. It does not think; but the observation of this device in action calls to mind a pair of extremely powerful human hands directed by a brain, making taut loops around packing boxes, cutting the wire after twisting it into a good, solid joint, and going on to do the same with the other end of the box.

This machine has two levers, the inner ends of which show clearly in the accompanying illustration, one extending to left, the other, having a bifurcated inner end, extending upward. These levers do the work, in company with a good pair of biceps. As shown here the job has been finished and the device is ready to begin the next tie, which will go something like this: The machine will be placed on the box and the wire formed with a head at one end so that it may be hooked under the little latch visible at extreme lower right. Then it goes through the gear and the hollow circular cutter, which latter does not, however, cut until the tie is finished. The free end encircles the box and comes back alongside the fixed end, continuing to the tension winch at the left.

The left hand lever is worked until the wire is tautened, and then locked. Now the twisting is done by means of the other lever (whose handle has, like that of the first lever, been sacrificed



Machine for wire-tying small and large packages



Flash-light gun with large advantages over the more familiar model

to the practical eye of the space-jealous editor as being taken for granted). Finally the wire is automatically cut and when the handle is brought smartly to full back position, two round push-rods faintly visible behind the twisted joint, pop out and eject the whole wire. The tie is finished.

A Fence You Can't Drive Through

MANY highway accidents to motorists are a result of going over cliffs and bridge-sides. Roads that skirt along the faces of very steep hills, or that run along the tops of cliffs are generally "protected" by means of wooden guards. In many of these cases the protection is largely psychological. One feels safe as long as the edge of the road has a barrier. Even if the barrier is a light fence of wood there is that same misleading feeling of security. Take away the frail fence and one would drive very gingerly in the same place. Yet in many places of this sort there is for all practical purposes no guard rail at all; a moving car would crash through as easily as a dog jumps through a paper ring in a circus. One remedy is heavy masonry, or concrete, but this is expensive. Moreover, when the errant car connects it generally comes out second best—and decidedly second hand. But a Bridgeport, Conn., manufacturer has found a way around the difficulty, and a way to keep the wobbling car on the right of way without battering its face too severely. This is a specially fabricated wire material which, owing to its mesh design, is highly elastic. Instead of attempting to bring the moving car up instantly, which cannot be done, it brings it up slowly. This fence has been tested by the Underwriters' Laboratories.

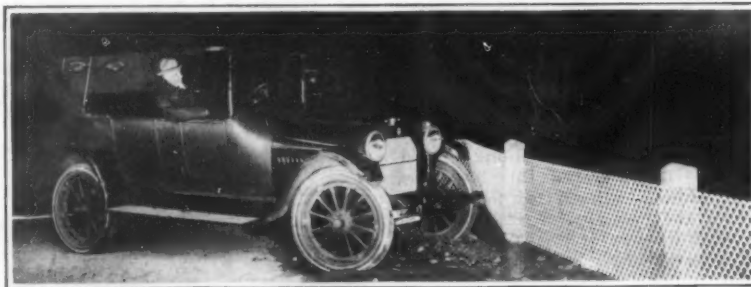


Suction blower installed on a stand—ard toilet-bowl

It was stretched between two regulation posts, using ordinary 1½-inch staples for attachment. Then, to simulate the blow struck by a car, a 650-pound weight suspended from a 68-foot line was drawn back 30 feet and released, swinging like a pendulum against the fence. The fence absorbed the blow like a Jack Dempsey and came back for more. Now, since the mathematical editor assures us that S equals $\frac{1}{2}GT$, we know that this blow was equivalent to that struck by a 3000-pound car moving at twenty-miles per hour. The Underwriters gave it their "O.K.," and we next hear that the Ohio State Commission has ordered a section of it installed at a famous "Death Curve" near Columbus. Such material as this would doubtless serve equally well to give the "Stop-and-come-back" command to those aspirants after sudden death who insist on rushing the gates at railway crossings and driving upon the tracks just as the train comes along.

A New Flashlight Gun

A NEW device for the igniting of photographic flashlight powder is the subject of a recently granted United States patent, 1,480,162, to B. Grotta. This gun is unique in that it utilizes for the ignition unit an electrically operated match-head such as are employed in large numbers in the setting off of commercial electric detonators. The device, as shown in the accompanying photograph, is made of a single piece of cast aluminum which is provided with suitable clips for holding the match-head and with means of making electrical



A guard rail that really guards for the steep bank and grade crossing

contact. The handle is hollow and contains a standard flashlight 2-cell battery which supplies sufficient electrical energy for several thousand match-heads. Contact may be made either with a conveniently located push button switch or extension wires may be plugged into a suitable receptacle and contact made by means of a push button switch attached to the other ends of these wires. The plug closing the lower end of the hollow handle bears a standard tripod socket which permits the gun's being mounted on a tripod.

Among the advantages claimed for this gun are instantaneous action, compactness, reliability, capability of being operated from any desired distance so that the operator may be "in the picture" himself, capability of firing several guns simultaneously by closing one switch, and low cost and ease of operation.

The Ventilated Toilet-Bowl

BY means of an electrical contact which is in effect only while the seat is occupied, a Kansas firm provides means for removing all objectionable odors from the bathroom. The apparatus embodies a suction fan, capable of removing something like eighty cubic feet of air per minute from the toilet-bowl. The air thus removed is carried outdoors by means of tubing, and is of course automatically replaced by clean air from indoors. The device is of convenient size, easily installed, and finished to harmonize with its surroundings.

A Loom in a Hand Satchel

EARLY typewriters afford no greater contrast against the ultra-modern portable machine than do early looms against the portable loom invented by Mrs. A. N. Shook, of New York. This loom folds up like a campchair, fits into a carrying case, and is carried about from place to place with the utmost ease. It weaves all kinds of fabrics, from silk to heavy wool. It is designed for use in schools, and by women who like to do hand weaving to earn money in their spare time or to satisfy their desire for seeing designs of their own production turned into cloth.



Portable loom on which real weaving can be done

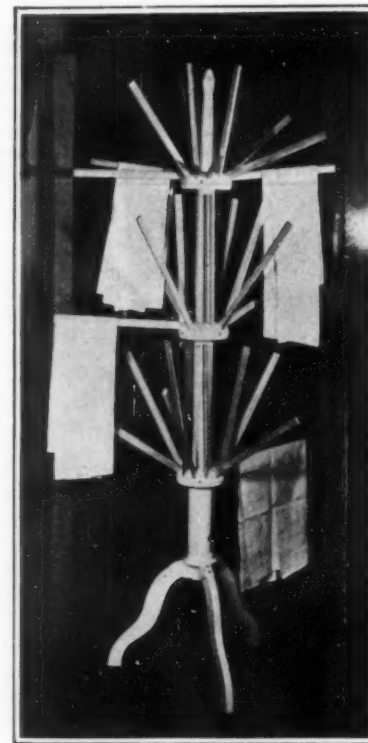
Direction of Ejection of Photo-Electrons by Polarized X-Rays

STEREOSCOPIC photographs were obtained by Frank W. Bubb, using Wilson's cloud expansion method, which show the ionized tracks of photo-electrons ejected by plane-polarized X-rays. The polarized X-rays, scattered by a paraffin block at 90 degrees to an unpolarized primary beam of hard X-rays, were directed horizontally through the expansion chamber of a Wilson cloud apparatus in which they produced the photo-electrons. Exploded tungsten wires furnished the instantaneous illumination of the droplets. The photographs, taken with the plate at 90 degrees to the polarized beam, show two types of asymmetry in the direction of ejection of the photo-electrons. Latterly, there is a strong concentration of photo-electrons ejected nearly in the direction of the electric vector of the plane-polar-

sults over the whole range of wavelengths. This failure may very well be due to the inaccuracy in the experimental results since the method of calculating the mass-scattering coefficient from measurements made upon compounds necessarily magnifies the experimental errors very considerably owing to the smallness of the scattering of hydrogen as compared with that of the remaining constituents. The importance of obtaining reliable data is pointed out and it is suggested that sufficiently accurate results can be secured only by using the element in the free state.

The Drying Tree

WHEN the very obvious object of the adjoining picture was brought into our office and set down before our startled eyes, it didn't have any towels hanging upon its arms to identify its purpose; and opinion was divided among certain members of the staff as to whether it was a new-fangled hat-rack or a synthetic Christmas tree. The parties to this argument, however, were all single; the instant one of our Benedicts got his eyes upon it, he identified it for the drying rack which it is, and demanded to know where he could buy one like it. Very plainly it provides a lot more drying space than the usual rack of more or less similar design; and very plainly, when it isn't drying anything, it folds up into marvelously small compass.



Domestic drying rack of unusual compactness and capacity

ized radiation performing the ejection. Longitudinally, stereoscopic examination of the photographs shows one-sixth of the photo-electrons ejected with a component opposite to the beam, one-third ejected approximately at right angles to the beam, and one-half ejected with a component along the beam. As regards, theoretical interpretation according to the classical and quantum theories, the results are in accord with the classical theory. To explain them on the quantum theory we must assume that the quantum is a vector bundle of energy, for it explodes, so to speak, at right angles to its direction of motion.

On the Scattering of X-Rays by Hydrogen

IN a paper under the above title in the *Physical Review* for February, by G. A. Schott, measurements of the absorption and scattering of X-rays by hydrocarbon compounds made recently by Aurén, by Hewlett, and by Olsen, Derstem and Storch, are considered critically insofar as they serve for the calculation of the mass-scattering coefficient of hydrogen for different wave-lengths and its comparison with the results computed on the basis of (1) the simple pulse theory, (2) the electron ring theory, (3) the ring-electron theory and (4) the quantum theory of scattering recently proposed by A. H. Compton. It is found that none of these theories, even when it is interpreted in the widest sense, agrees with the experimental re-



Ingenious tackle that adds to the safety of the man who works on the face of tall buildings

Sure-Fire Safety for the Human Fly

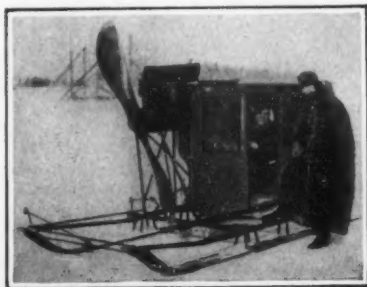
SAFETY for the worker whose job lies somewhere between the sidewalk and the roof of a tall building—safety for him of a degree never previously approached—is the aim of the tackle illustrated herewith, which has been tried out recently in Paris, with great success. The cable is rigged to a secure mooring on the roof, and threaded through the framework of the basket in which the workman is to travel. A fool-proof handle control, shown above the workman's knees in our photograph, makes it possible to grip this cable, at the point indicated, in a fashion which absolutely insures the safety of the man in the basket.

A Turf Cultivator

AN Ohio man has invented a cultivator for lawns and golf course greens that incorporates several features of unusual worth. The machine is designed for use on hard ground where grass either grows in small quantities or does not exist at all. Its purpose is to cultivate turf of all kinds without destroying it, but rather to make it more luxurious and thrifty.

The feature of the cultivator is the arrangement of the ten disks that make a total of 48 incisions, 2 inches long and 2 inches deep, to the square foot at one cultivation. The disks are $1\frac{1}{2}$ inches apart on the shaft, which is 15 inches wide.

The cultivator has been constructed so that the cutting blades in the form of teeth, operating to a depth of two inches, cut the surface of a hardened turf into blocks, $1\frac{1}{2}$ inches square, allowing these incisions to be separated by sand or fine organic matter so that the surface can never again become hard



Motor-driven sled recently displayed on the Quebec ice

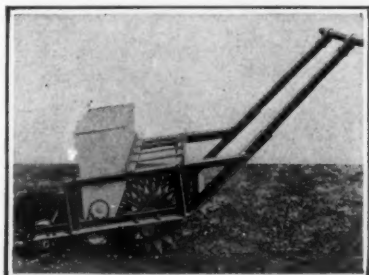
and compact. Penetration is effective without creating permanent punctures, due to lateral pressure, as would be caused by driving spikes into the soil. As the cutting teeth of this cultivator come from the soil, they are lifted directly from the incision, thereby leaving the surface intact.

The machine in operation permits the incorporation, in the top two inches of soil, of 19 cubic inches to the square foot of material such as sand, seed or organic matter at one cultivation or operation. Cross-cultivation increases the number of incisions and doubles the quantity of material available for the lawn or other turf. Persistent cultivation with this machine adds materially to the softness of the lawn or turf.

The machine is equipped with a box for the holding of seed, sand, organic matter or lime, as required. A distributing device, attached to the machine, makes possible the filling of the incisions at the time of cultivation. This has been proven the only device, the inventor claims, that will create proper turf conditions with the minimum amount of labor on lawns or golf courses.

The supply box holds fifty pounds of organic matter. The bottom slots correspond to the disks on the machine and two agitators stir the material, forcing it through the slots into the incisions made by the disk teeth. A carrier for added weight is included in the machine, making it possible to cultivate the turf to almost any depth. However, if the turf is properly watered, but little added weight is required.

The machine makes it possible to seed a turf at the time of cultivation by mixing the desired amount of seed with the other matter being used. The germinated seed at once develops a two-inch rootage and is insured a constant supply of moisture through the porosity of the material filling each incision. Used at intervals of two weeks, it is claimed, from four to five tons of organic matter may be applied to a surface of about 7000 square feet, insuring the porosity and sponginess necessary for a deep-



A turf-cultivator for lawns and golf greens

rooted turf as in the case of a golf green where perfect playing conditions are almost a necessity.

In the case of use on a golf green, play is not stopped during the operation of cultivation. Incisions not filled with organic matter or other material, immediately close upon watering, thus doing away with the use of a roller. To insure perfect working conditions of the machine, turf to be cultivated should be thoroughly wetted before the cultivator is used. It is also claimed that the machine represents the only method by which lime may be deeply and properly applied to blue grass turf or golf greens.

The machine operates at the speed of an ordinary lawn mower and is easily drawn by two men.

Winter Sports a la Airplane

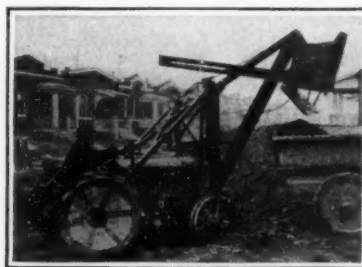
THE development of the airplane is responsible for a number of devices for making use of screw propulsion without leaving the ground; and of all these,

none is more efficient than one in which this type of power plant is mounted on a sled of some sort. We illustrate an obviously home-assembled outfit which was recently seen on the ice at Quebec. An ordinary automobile engine and the remains of a closed-car body have been combined with a perfectly regular airplane propeller and a set of light runners of, apparently, nondescript origin—and there you are! No data are offered regarding speed, but the position of the exhaust pipe is a guarantee of sufficient noise to satisfy the most ardent motor-sleighman.

A Small-Scale Shoveling Machine

THERE has always been a gap between the steam shovel and the spade, lots of jobs being too small to be handled by the one but too large for profitable prosecution with the other. A small digger for operation in connection with the ordinary farm tractor is now offered, which seems to fill this gap admirably.

The machine was designed primarily



Bridging the gap between the spade and the steam shovel

as a loader and in this connection it is used without teeth. With the truck or wagon set parallel to the machine, the only movement required is to drive the tractor forward several feet, hoist the bucket, and back a few feet alongside the truck, when the boom can be swung over for dumping the load. The photograph shows the truck backed up against the outfit, for use in a slightly different fashion. The hoisting drum for the main cable can also be used as a contractor's hoist on small jobs, while the bucket can be removed after taking out a single pin, putting the outfit in shape for use as a baby locomotive crane.

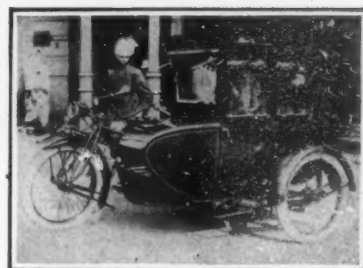
There are many places where this little loader can be used with effect. In the filling of concrete-mixer skips from stock piles, in work along the shoulders of roads, in snow clearing, and in a variety of work done ordinarily by hand shovels, it is available.

A Handy Gadget for the Magazine Subscriber

HOW do you remove the wrappers from tightly rolled newspapers or magazines? The usual attempt to tear the wrapper off is discouraging, as the tight paper refuses to tear. Attempts to use a knife are similarly disappointing, because of the danger of mutilating the contents of the wrapper.

The problem has been solved by a cutter devised by Arthur F. Hoffman, a rural mail carrier at Harvard, Neb., recently submitted to the Post Office Department and approved by the Postal authorities. This cutter is in the form of a knife with a curved and flattened tip. The flat point is easily inserted underneath the wrapper and a forward movement of the instrument results in clean cutting of the covering without damage to the contents.

The Post Office Department finds that the cutter may have value for rural carriers in cutting the twine with which packages of mail are fastened. Injury to the mail is considered practically impossible.



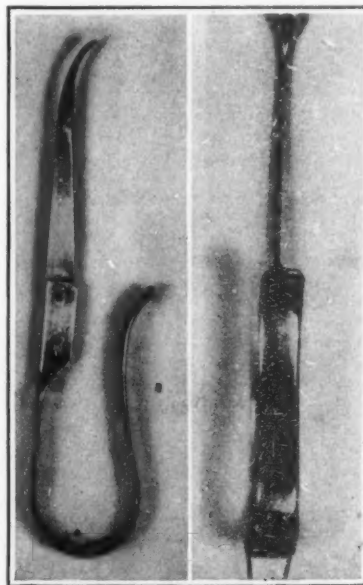
Cycle-and-side-car taxi from the streets of Calcutta

The Side-Car Taxicab

THE jinriksha still prevails in Japan, and equally primitive ways of applying human leg-power to the transportation of the upper crust of human society rule in other corners of Asia. But the taxicab and its cousins are to be found in surprisingly out of the way places, and it looks as though the human beast of burden were up against tough competition. Something rather novel in the way of taxi service, the photograph of which comes to us all the way from Calcutta, is the immediate source of inspiration for these remarks. The thing is of the three-wheeler species, better known in the American tongue as motor-cycle with side-car. But it is a most sumptuous and elaborate rig, as our photograph indicates. The dark-skinned person in charge, we have no doubt, is the aristocrat of his caste, and looks down with condescension upon those of his brethren who still have to apply elbow-grease and knee-power to the moving of their loads.

The Electrical Properties of Flames

THE capacity and equivalent series resistance of a condenser consisting of two concentric platinum cylinders, 0.5 cm. apart, in a flame containing K_2CO_3 vapor, were measured by A. B. Bryan, using a modification of the method of resistance variation. Values are obtained for voltages between 11.4 and 82.2 volts, for frequencies between 2×10^5 and 10^6 cycles per second and for salt concentrations up to 10 grams per liter of K_2CO_3 solution. The resistance is approximately independent of the field but decreases somewhat as frequency increases, and also as concentration increases. The capacity is half as great for 11 volts, and for 10×10^5 as for 2×10^6 cycles, but increases greatly as the concentration increases.



For opening tightly wrapped magazines without damage to the pages

The Heavens in June, 1924

The Fall of the Nebular Hypothesis, and the Rise of a Plausible Substitute

By Professor Henry Norris Russell, Ph.D.

AMONG the many hard questions which the layman often asks of the professional astronomer, one of the commonest is, "How did the solar system get there?" But it is not "the man in the street" alone who asks this. For a century or more, men of science have been putting this great question of our origin to themselves, to one another, and to Nature herself—and though we would be far today from claiming that we know the full and complete answer, we hope that we have some inkling, at least, of its character.

The first serious attempt at such an explanation was made, more than a century ago, by the great philosopher Kant, and put into physical form by the equally great astronomer, Laplace. According to this well known "nebular hypothesis," the solar system originally formed a single rotating mass, which from age to age gradually cooled and shrunk, and was thus forced to rotate faster and faster. Finally its rotation became so rapid that centrifugal force at the edge gained the upper hand, neutralizing the attraction of the mass, and part of the matter was ejected, forming a ring, which later coalesced into a planet. A succession of such events, it was assumed, led to the formation of the planetary system as we know it.

This familiar theory has the great advantage of accounting for most of the main features of our system—the existence of many planets, all moving in the same direction, in nearly circular orbits, in almost the same plane. But attractive as it is, it breaks down disastrously in detail, and makes complete shipwreck on the rock of angular momentum.

Why Laplace's Theory Will Not Work

What this means we can see in a moment. To find the "angular momentum" of any planet in our system, we take its mass, its distance from the sun, and its speed in its orbit (or, more precisely, the part of this speed which is at right angles to the radius joining the planet to the sun); and we multiply these three factors together. Do this for each planet, and also for the rotating sun itself (taking each part separately, and adding the results). The sum, for all the planets and the sun, is the total angular momentum of the system (the rotations of the planets, and the motions of the satellites, contribute too little to count). Now, from the principles of mechanical science (discovered by Newton, and firmly established by the works of innumerable investigators ever since), it follows that any action of one planet on another, or of the sun on any or all, can only transfer this angular momentum from one part of the system to another. What one part loses, another part gains; and the total amount can be altered only by action proceeding from without the system.

Now when the angular momentum of the solar system is calculated, it is found that more than 98 per cent of it resides in the orbital motions of the planets (mostly in Jupiter and Saturn) and less than 2 per cent in the rotation of the sun—and yet the planets, all together, have only one-seventh of 1 per cent of the mass of the system. Any theory of the origin of the system must account for the strange fact that so small a fraction of 1 per cent of the mass carries more than 98 per cent of the angular momentum; and no one has ever been able to devise any explanation how this could have resulted from internal forces, operating solely within the system. It is not, of course, impossible that some such explanation might be devised; but nothing of the sort has ever been done, and it can be proved that the theory of Laplace, in particular, is incapable of it.

It appears, therefore, to be very improbable indeed that our solar system has come into being by the action of internal forces. Rather must we look to some external force, which, in the same action, removed a small fraction of the sun's mass to form the planets,

and imparted to them their circulating motion and their present great angular momentum.

Such a force may be found in the attraction of a passing star—provided that, at some remote period, another star happened to pass very near the sun. What would happen then was first suggested by Chamberlin and Moulton, of Chicago, and has since been worked out in mathematical detail by the Englishmen, Jeffreys and Jeans.

The Solar System Born by Chance

As the visiting star approached the sun, its action would raise tides in the fluid mass of the latter, which would become higher and higher as the intruder came nearer. So long as the star did not come within three or four diameters of the sun, these tides, though rising perhaps to heights of tens of thousands of miles, would sink back again as the star departed on its way. But if the star came too near, the solar tide would rise so high that it could not stop rising, and when the star

the middle of the series. These great planets must still be largely gaseous, and they are attended by extensive satellite systems—miniatures of the solar system, which Jeans attributes to eruptions from the new-formed planetary masses, under the influence of some close approach, perhaps to the sun. For the earth and Neptune, each of which has a single relatively large satellite, Jeans thinks it likely that the mass soon became liquid, and then shed a relatively large portion of itself. Venus and Mercury, which have no satellites, may well have cooled down and become solid fast enough to prevent disruption.

The general outlines of the planetary system appear thus to be well accounted for, and we have the excellent authority of Jeans (from whose discussion much of the above is borrowed) for pronouncing this theory to be reasonably satisfactory. Jeffreys has shown, in addition, that the collisions between the large condensations (the planets) and the small ones which doubtless also existed at first, would gradually operate to clean up the latter, and to make the orbits of the planets themselves rounder and rounder. To reach their present nearly circular orbits, he figures, probably took several billions of years. This estimate agrees very well with those for the age of the earth which have been derived in quite another way from radioactive phenomena.

The Planets

Mercury is a morning star all through June, and is best seen at the beginning of the month, about the time of the elongation on the 3rd. He is then 24 degrees from the sun but nearly 9 degrees south of him, so that he rises only about one hour and ten minutes before the sun, and is not conspicuous.

Venus is still an evening star, conspicuous in the early part of the month, but drawing in closer and closer to the sun until she is lost to view before its close. Telescopically she is a beautiful object—a crescent like the moon four days old when the month begins, but growing ever narrower, and at the same time larger in diameter, until she becomes merely a thin semicircle of light.

Mars is in Aquarius, and is steadily growing brighter as he approaches us. By the end of the month he is only fifty million miles away, is 17 seconds in apparent diameter—two-thirds of the maximum value which he will reach in August—and looks almost as bright as Sirius. He is still far from opposition, and does not rise until after 10:30 P. M.

Jupiter is in opposition on the 5th, and is visible all night long. He is in Ophiuchus, on the edge of Scorpio, and nearly 22 degrees south of the celestial equator.

This counts against him in our latitude, but even so, he is brighter than anything else in sight except Venus.

Saturn is in Virgo, about 5 degrees east and a little north of the bright star Spica, which he somewhat surpasses in brightness. He is due north at 8 P. M. in the middle of the month, and remains in sight until 1:30 A. M. Uranus is in Pisces, and comes into quadrature west of the sun on the 12th, rising just after midnight, and being observable in the early morning. Neptune is in Cancer, and is well down in the west at sunset, so that he is hardly observable, even with the telescope.

The moon is new at 10 A. M. on the 2nd, in her first quarter at 9 A. M. on the 10th, full just before midnight on the 16th, and in her last quarter at 9 P. M. on the 23rd. She is nearest the earth on the 16th, and farthest away on the 1st and again on the 29th. During the month she is in conjunction with Mercury on the 1st, Venus on the 5th, Neptune on the 7th, Saturn on the 12th, Jupiter on the 16th, Mars on the 21st and Uranus on the 22d.

On the 28th, the bright star Aldebaran is occulted by the moon, and is hidden (from Washington) for more than an hour, from 8:30 to 9:48 A. M. As this happens in broad daylight, it can unfortunately be seen only with fair-sized telescopes.



At 11 o'clock: June 7.
At 10½ o'clock: June 14.
At 10 o'clock: June 22.

At 9 o'clock: July 7.
At 8½ o'clock: July 14.
At 8 o'clock: July 22.

At 9½ o'clock: June 30.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on June 7, etc.

NIGHT SKY: JUNE AND JULY

was nearest, part of the sun's substance would flow out from the regions of high tide—one facing the star and the other opposite it—and form long streams or filaments of gaseous material. The attraction of the parts of this stream for one another would then cause it to break up crosswise into separate condensations (as a long thin stream of falling water breaks into separate drops), while the attraction of the passing star, still near by, would pull these sideways and set them circulating about the sun.

After a few months or years, the passing star would have receded so far that its influence ceased to be important. The ejected matter would be left moving around near the sun—some to fall back into it, some perhaps to fly off into space, but much to remain circulating about the sun. All the condensations would move around the sun in the same direction, and nearly in the same plane—that of the hyperbolic orbit of the visiting star. As they settled down to orderly existence, after the great catastrophe, we may see in them the newly-born planets.

Jeans has pointed out that such a filament of ejected matter would be likely to be thin at the ends and thicker in the middle—which fits in well with the fact that the greatest planets, Jupiter and Saturn, are near

Recently Patented Inventions

As a convenience to our readers, we will supply copies of any patents listed herein for 15 cents each. The official printed copies of patents include complete descriptions and drawings of the inventions disclosed. State the patent number to insure receipt of the desired patent copy.

Pertaining to Aeronautics

AIRCRAFT—Consisting of two gas bags joined at the front and rear ends, the propellers being disposed adjacent the under side. Patent 1481448. J. Whalen, 811 Oakdale Ave., Chicago, Ill.

Chemical Processes

PROCESS FOR THE PRODUCTION OF THERAPEUTICALLY-ACTIVE CONSTITUENTS OF OILS, BALSAMS, RESINS AND EXTRACTS—By means of a cholic acid. Patent 1479095. F. Boedecker, Berlin-Tempelhof, Germany.

TREATMENT OF SULFUR AND OXIDIZED ORES—Especially applicable to ores containing minerals of silver, lead, and zinc. Patent 1480439. H. J. E. Hamilton, North Broken Hill, New South Wales, Australia.

Electrical Devices

INDICATING DEVICE—For visually indicating to the occupants of a kitchen an order taken at a remote point. Patent 1479098. B. James, 4035 Indiana Ave., Chicago, Ill.

ELECTRICAL INSTANTANEOUS WATER HEATER WITH CONTINUOUS CIRCULATION, WORKING AT DIFFERENT VOLTAGES—Adapted to be fixed at any water supply. Patent 1480515. A. DeMarchis, 212 Via Cola de Rienzo, Rome, Italy.

CIRCUIT CLOSER—Which operates when the temperature drops below a predetermined point or in the event of fire. Patent 1480102. J. C. Olsen, address Mrs. S. Olsen, 3915 3rd St., N. E. Minneapolis, Minn.

CIRCUIT BREAKER—Subject to fluid pressure in a cylinder, as for example a fire pump. Patent 1480442. J. T. Heck, Hendrick, Ind.

HOODED EXAMINING LAMP—Illuminated by small electric bulbs, and capable of being worn on the face in the manner of spectacles. Patent 1481224. A. Pimienta, 63 W. 68th St., New York, N. Y.

CIGAR LIGHTER—Operated by means of an electric current and adapted for use on automobiles. Patent 1481383. J. Nelson, Winter Park, Fla.

TROLLEY-WIRE GUARD—Designed for use in protecting trolley wires mounted in mines. Patent 1481693. G. W. Creech, Twila, Ky.

ELECTROMECHANICAL LAMP—In which the bulb contact is composed of a flexible metallic strip, not susceptible to jars or shocks. Patent 1483055. P. Blot, c/o Societe Blot-Garnier & Chevalier, Paris, France.

ELECTRIC FENCE—The wires of which are only energized at the time a person or animal attempts to pass through. Patent 1483005. A. D. McNair, Fayetteville, Ark.

ELECTRIC CONNECTION—Whereby conductors may be joined by a compact metallic lock, without the use of solder. Patent 1482288. C. A. Deuschler, 233 St. Anns Ave., Bronx, N. Y.

RADIO APPARATUS—In which positive electrical connections are established between the station coil and rotor coil in a minimum capacity. Patent 1481959. R. W. French, 508 S. Francisco Ave., Chicago, Ill.

Of Interest to Farmers

ANIMAL HOPPLE—Particularly intended for preventing a cow from kicking while being milked. Patent 1480443. E. Herman, Fairfield, Iowa.

DRAFT EVENER—Adapted for attachment to a grain harvester, or other farm implement. Patent 1480204. C. T. Hansen, Big Sandy, Montana.

GUARD FOR HARVESTER—Particularly adapted for harvesting oats, in a field where corn was grown the preceding season. Patent 1480244. U. H. Cramer, R. No. 2, Box 60, Minonk, Ill.

UNLOADING DEVICE FOR CORN—Having means for storing the corn into a plurality of piles, which may be readily moved from the wagon. Patent 1482093. P. M. Rindesbacher, c/o Peoples State Bank, Stockton, Ill.

7. TITLE TO PATENT RIGHTS

TITLE to a patent right is vested in the first instance, by "occupancy," in the inventor of the subject-matter thereof. This title to the personal property which a patent right constitutes, is inchoate during the period between the creation of the invention and the issue of the patent. Nevertheless, this inchoate right is assignable, and such assignment will convey legal title to the letters patent when granted, and if the deed of assignment so requests the Commissioner of Patents, the patent will issue to the assignee direct. An assignment of a patent, which must be in writing, may be both conditional and unconditional, entire or partial, and may even be limited territorially or in point of time. While a true assignment must be in writing, an equitable assignment, that is one which is really an agreement to assign, may be oral. Under our statutes, recording an assignment in the Patent Office within three months of its execution, is necessary to insure title in the assignee, as against a subsequent purchaser for value and without knowledge of the assignment. Title to a patent does not pass to the heir of a deceased owner of the patent, but goes to the executor or administrator of the estate, and he alone can effect a transfer, though of course patent rights may be disposed of by will or in accordance with the laws of decedent estates as in the case of any other personality. A patent may be assigned to a married woman, an infant or even a person under guardianship, and such parties may also assign their inventions or patents by complying not only with the provisions of the United States statutes, but also with the laws of their particular states, covering such transfers by persons of that status in respect to other personal property.

Of General Interest

CONNECTOR FOR LOOSE LEAF BINDERS—That may be attached to a fabric by pressing the members into engagement. Patent 1479740. L. Reiter, 102 Westfield St., Providence, R. I.

SHUTTER ATTACHMENT FOR DOORS—By means of which a door may be secured partially opened. Patent 1479312. Lydia M. O'Harrow, 431 So. Dubuque St., Iowa City, Iowa.

HAND BAG—Which admits of ready access, for the removal and placing of articles therein. Patent 1479763. N. Wendel, 1336 Decatur St., Brooklyn, N. Y.

DRAWING APPARATUS—Whereby the operator could derive considerable assistance in reproducing objects. Patent 1479691. R. P. Anstock, 26 West Center St., Mahanoy City, Pa.

FISH LURE—With a smooth outer surface to prevent entanglement with weeds, hooks being concealed. Patent 1479652. C. Cranstone, 210 34th St., Newport News, Va.

RECEPTACLE—In the form of a hand bag, or the like, with reinforced frame. Patent 1479699. H. Delman, 1595 Madison Ave., New York, N. Y.

MATCH STRIKER—Especially adaptable for use on the ordinary corn cob smoking pipe. Patent 1479427. W. Chalmers, 1024 4th St., Sacramento, Calif.

COMPOSITE BRICK AND TILE WALL CONSTRUCTION—Which provides a continuous vertical air passage through the wall. Patent 1479379. W. G. Demarest, 47 W. 34th St., New York, N. Y.

DENTAL FLOSS HOLDER—Whereby the floss may be held under tension. Patent 1479364. W. R. Browne, Wyoming, N. Y.

TRIPOD—With provision for locking the legs against movement on a slippery surface. Patent 1479765. E. E. Whiting, Miller, Mo.

TABLE—Having means whereby desired lengths may be measured and cut from a roll of fabric. Patent 1480168. W. S. Lambert, c/o Lambert Dry Goods Co., Geneseo, Ill.

LAWN SPRINKLER—By means of which the water is spread with a revolving action. Patent 1480507. G. W. Coblenz, J. R. Faries, and H. P. Bond, c/o Fisher Flouring Mills Co., Tacoma, Wash.

EDUCATIONAL APPLIANCE—For producing objects, geometrical figures, scenes or the like, in colors. Patent 1480458. S. D. Mershon, 222 West Milton Ave., Rahway, N. J.

COMBINED POSTAL AND ADVERTISING PHYLAR—For receiving mail matter, and which may also be illuminated to display advertising matter. Patent 1480469. G. Robertson, 297 Carrington St., Adelaide, South Australia.

CARD HOLDER FOR TYPEWRITERS—Which is capable of use with any standard make of typewriter. Patent 1480440. W. A. Hardman, 98 So. Oxford St., Brooklyn, N. Y.

SASH-GEAR BALANCE—To prevent the binding and sticking of window sash. Patent 1480453. L. Lane, Estacion Laquna, Chihuahua, Mexico.

DRY-MASH-FEED HOPPER—With agitating means for causing the feed to be discharged into the feed trough. Patent 1480497. M. Brandt, Toms River, N. J.

LIP STICK HOLDER—Adapted to project the cosmetic when it is desired to use the same. Patent 1480449. W. G. Kendall, c/o H. Rigaud, 75 Barrow St., Newark, N. J.

GUN—Which may be gripped within the palm of the hand, and carried concealed for defence. Patent 1480521. J. Fallor and I. Lapidus, 1960 66th St., Brooklyn, N. Y.

TOILET SEAT—Arranged to accommodate either a sectional wood filling or a composition filling. Patent 1480516. G. C. Dobson, 230 Ancon Ave., Pelham Heights, N. Y.

FLY PAPER—Which may be used in cone shape upon a table or may be suspended. Patent 1480539. J. Grecu, 6042 12th St., Detroit, Mich.

POISON DISTRIBUTOR—For use in dispensing poisons for killing insects on cotton or potato plants. Patent 1480154. P. E. Crutchfield, address R. L. Brackwell, Calhoun, Ga.

ANIMAL TRAP—Adapted either for trapping moles, rats, weasels or other animals. Patent 1479853. I. C. Gambee, 3639 44th Ave., S. W., Seattle, Wash.

BRIEF BAGS—With strip elements reinforcing the same, and a space for identification card. Patent 1481182. M. Brooks, c/o Lefton Mfg. Co., 15 W. 27th St., New York, N. Y.

GROMMET—Formed from a single piece of metal, as a substitute for two-piece grommets. Patent 1481217. R. E. Maloy, 1146 Lake St., Oak Park, Ill.

ADVERTISING DEVICE—Comprising a panel, cut out to receive a specimen of the article advertised. Patent 1481171. M. R. Wood, 218 William St., New York, N. Y.

THREAD FOLDER AND CUTTER—Which may be attached to the center of the spool by spring means. Patent 1481185. J. H. Burns and J. Anderson, 12 E. 86th St., New York, N. Y.

ICE REMOVING APPARATUS—For removing blocks of manufactured ice from the cans in which they are formed. Patent 1480703. J. C. Ward, c/o R. E. Masterson, 441 Keith Bldg., Beaumont, Texas.

RULE—Adapted for use by opticians, optometrists and oculists. Patent 1480584. E. M. Wilhite, Shelbyville, Ind.

FISHING FLOAT—Which may be quickly attached to or removed from a line without knotting the same. Patent 1480655. G. E. Bennett, 25½ No. Centre St., Corry, Pa.

BRIDGE TOOTH AND LOCK-IN BACKING—Whereby the tooth is firmly united, but capable of ready removal in the event of breakage. Patent 1481209. A. A. Kauffman, 756 Broadway, Brooklyn, N. Y.

AQUARIUM—Having no metal on the interior to injure the fish, and which is leak-proof. Patent 1481435. W. Rossberger, 1030 Greenleaf Ave., Wilmette, Ill.

ROLLER WASHLINE—In which the wash line may be rolled up and enclosed when not in use. Patent 1481497. J. Betz, 1114 St. Germain St., St. Cloud, Minn.

ATTACHMENT FOR BEDS, CHAIRS AND THE LIKE—Which affords facilities for raising or lowering a swingingly supported section. Patent 1481756. S. E. Stickle, Fort Rock, Oregon.

BASE FOR POSTS—Such as cement fence posts, stock-yard posts, and poles supporting electric wires. Patent 1481745. J. R. C. Ruybal, Capulin, Colo.

CORD CUTTER—With means for guiding the cord to the knife and preventing injury to the fingers. Patent 1481725. G. W. Moore, 75 Blanco Place, Jamaica, N. Y.

CHECK-BOOK CLAMP—For holding or folding check book in a flattened condition when in use. Patent 1480196. R. W. Cudworth, 1144 Leavenworth St., San Francisco, Calif.

KNOT-TYING DEVICE—For forming knots in twine used in tying up packages and the like. Patent 1481754. M. Stalson, 205 22d Ave., North Minneapolis, Minn.

BATH—So arranged that when out of use it looks like a chest, or piece of furniture. Patent 1481675. K. Beresford, 16 Karl Theodorstrasse, Meran, Italy.

SLING FOR CONTAINERS—For supporting container for fruit when it is being picked, thereby saving one handling of the fruit. Patent 1481418. A. E. Darby, Lakeside, Wash.

COAL-SAVING COMPOSITION—Consisting of sand, fine coal, ashes, salt, and water to make a mortar-like mass. Patent 1481456. O. O. Cooper, c/o Chicago & Great Lake Co., 311 River St., Chicago, Ill.

PHOTOGRAPH AND THE LIKE—Referring to the mounting of a photograph to produce a novel appearance. Patent 1480198. Josephine Denkhoff, 1326 49th Ave., San Francisco, Calif.

TRAVELING BAG—Which presents a neat, smooth finish on the inside adjacent the hinges for opening and closing. Patent 1480175. E. G. Merwin, 549½ Williams Ave., Portland, Ore.

MOTION PICTURE SCREEN AND METHOD OF PRODUCING SAME—The screen being adapted to reflect pictures with a minimum strain on the eye. Patent 1480205. L. W. Hill, 2219 Geary St., San Francisco, Calif.

CIGAR LIGHTER—In which the gas is completely cut off when not in use, and is ignited by electrical circuit. Patent 1482098. S. Stocking, Herscher, Ill.

COMB—The teeth of which can be readily removed for replacement or cleaning. Patent 1482242. S. Michaud, c/o Hotel Grand, Roseburg, Oregon.

ICE CREAM DIPPER—Including a bowl, having a guide lip and a scraper attached. Patent 1482094. W. R. Ripley, Sherman, Calif.

SCOREBOARD FOR BASEBALL GAMES—Provided with a housing for the operator who manipulates the indicator plates. Patent 1481916. L. D. Long, Charleston, S. C.

CURTAIN—For screening inclosed porches and the like, the device may be easily raised or lowered. Patent 1482059. S. B. Zimmer, 1253 W. 37th Place, Los Angeles, Calif.

BELT FASTENING HOOK—Having a plurality of shanks, hooks and tangs easily applied to belt ends as a fastening. Patent 1482282. M. L. Adams, 898 1st Ave. So., Seattle, Wash.

ROOFING TILE—With notched projections for engaging the notches of an adjacent tile. Patent 1482267. B. Schnitzler, 220 Hudson Ave., Edgemere, L. I., N. Y.

CLOTHESLINE SUPPORT AND TIGHTENER—Which affords means for lowering the line to permit the application or removal of the clothes. Patent 1482268. C. Schopper, 523 W. 134th St., New York, N. Y.

GALVANIZING RACK—By means of which a plurality of steel bars may be simultaneously handled for galvanizing. Patent 1482066. L. T. Curtis, 40 Bloomfield Rd., Burlingame, Calif.

CLOTHESPOLE—So constructed that a line supported thereby will not slip. Patent 1482278. B. Trent, 103 Trenton Ave., Lakeview, N. J.

COIN MAILING-CARD—Which is provided with slots, and retaining means for preventing the coins being disengaged. Patent 1482433. W. G. Hoffman and R. S. Hintze, 1234 N. Mansfield Ave., Chicago, Ill.

INSECT TRAP—Constructed to contain an insecticide particularly attractive to boll-weevil and other insects. Patent 1482992. A. Hoffbauer, 367 52nd St., Brooklyn, N. Y.

CURB COCK—In which all moving parts are protected from rust or corrosion by a casing of heavy grease. Patent 1483001. A. Kurre, 283 5th Ave., Brooklyn, N. Y.

BRIDGE FOR BILLIARD AND POOL TABLES—Which may be positioned at any angle with respect to the cue ball, irrespective of other balls on the table. Patent 1482962. W. W. Banks, 28 Merion Ave., Bryn Mawr, Pa.

PROCESS OF MANUFACTURING AND LAYING BITUMINOUS SHEET PAVEMENT AND MATERIALS THEREFOR—Enabling the pavement to be laid cold, and rolled to insure adhesion. Patent 1482960. F. C. Alsdorf, Box 417, So. Norwalk, Conn.

OUTFIT FOR PRODUCING DRINKS—For beverage, medicine or other purposes. Patent 1483015. H. Schnackenberg, Box 101, Stroudsburg, Pa.

DRESS SEPARATOR—Adapted to be suspended from a pole or other support between garments. Patent 1483058. P. M. Frank, c/o Nathan H. Jacobson & Co., 36 E. 31st St., New York, N. Y.

CHANGE PURSE AND BILL FOLD—Which will add but slightly in bulk to the usual form of bill fold. Patent 1483020. E. Sperling, c/o Sperling Co., 1261 Broadway, New York, N. Y.

DENTAL ARTICULAR OR RELATOR—Having movable jaws which permit of adjustment. Patent 1482993. J. Homer, c/o Homer Relator Co., 384 Atlantic Ave., Boston, Mass.

PACK OF GAME CARDS—On the corners of which appear numbers from 1 to 100, making possible the playing of fifty mathematical games. Patent 1484564. R. H. Riffert, 2405 W. Lehigh Ave., Philadelphia, Pa.

TOOTHBRUSH—Which will allow water to enter through the handle to the bristles, flushing the teeth at the time they are brushed. Patent 1479275. H. W. Beil, 551 Cedar St., San Francisco, Calif.

Hardware and Tools

EXPANSIBLE REIMER—In which the adjustable blades may be used in openings of various diameters. Patent 1479079. A. Kutcher, 921 Front St., Bismarck, N. D.

NUT LOCK—Of such construction that the nut cannot become loosened by vibration or shock. Patent 1479071. J. A. Hatfield, 511 W. Railroad Ave., Fort Worth, Texas.

HINGE CONSTRUCTION—Capable of bearing great strain, yet using a minimum of metal. Patent 1479705. E. Flagg, 111 E. 40th St., New York, N. Y.

BOLT AND CHAIN LOCK—Which may be used simultaneously or independently, the operation of both being independent. Patent 1479709. M. J. Goldstein, 237 E. 174th St., Bronx, N. Y.

PORTABLE HANDLE—In the form of tongs adapted for lifting boxes and the like. Patent 1479711. C. Haarberg, 3238 Flourday St., Chicago, Ill.

LOCK—Wherein the bolt cannot be retracted except by the actuation of proper means. The inventor has been granted two patents of a similar nature. Patents 1479743 and 1479744. A. Salata, 207 E. 15th St., New York, N. Y.

COMBINED SAW JOINTER AND GAGE—Provided with accurate means for vertically adjusting the sawing gage, and filing gage members. Patent 1481818. G. Anderson, Hotel Laina, 715 7th Ave., Seattle, Wash.

METAL FENCE POST—Having notches on its edges for attaching the wire retaining members. Patent 1479291. P. E. Evans, 60 E. 13th St., Chicago Heights, Ill.

DRILL HEAD—Whereby tools such as cutters may be introduced into a well casing. Patent 1479872. F. E. Sackrider, Apperson, Okla.

COMPOUND TOOL—Which acts as a pencil sharpener and finger nail cleaner. Patent 1479921. J. J. Miller, Box 608, Chadron, Neb.

DENTAL SHOULDER-CUTTING INSTRUMENT—Which provides means for shielding the gum and neighboring teeth from the cutting tool. Patent 1480730. J. A. Lentz, 44 No. 1st Ave., Phoenix, Arizona.

SHARPENER FOR SAFETY-RAZOR BLADES—Which will operate on blades of practically all the standard types now in use. Patent 1482265. J. M. Schiltz, 1908 Cadez, Dallas, Texas.

LOCK—Of the mortise type, having a sliding bolt and gear, whereby the operating members are interlocked. Patent 1482298. B. Greenison, 853 7th Ave., New York, N. Y.

JACK—Which will raise an object from close to the ground, and will provide for instantaneous release. Patent 1481822. W. Bengel, c/o Ark. Bank & Trust Bldg., Newport, Arkansas.

LOCK—In which rotation of the latch is prevented when desired. Patent 1482974. E. Daele, 2066 7th Ave., New York, N. Y.

APPLIANCE FOR CLAMPS OR CRAMPS AND THE LIKE—Which will effectually force together boards or pieces of timber during the process of nailing. Patent 1482989. L. F. Hering, 109 Cameron St., Launceston, Tasmania.

Heating and Lighting

RADIATOR BRACKET—For suspending a radiator from the side wall of a room, and eliminate supporting feet. Patent 1480456. E. J. Mallen, 2328 University Ave., Bronx, N. Y.

DRIER—Which will enable the analyst to determine the amount of moisture in laboratory tests. Patent 1482274. G. L. Spencer, c/o Cuban Am. Sugar Co., 129 Front St., New York, N. Y.

METAL-WORKING FURNACE—Particularly intended for use in connection with manufacture of wrought iron. Patent 1483062. O. S. Pulliam, Room 480, 50 Church St., New York, N. Y.

Machines and Mechanical Devices

GUARD—For speed governors on machinery, which may be moved for adjustments. Patent 1478953. L. and E. A. Hupp, 29 New Jersey Ave., Brooklyn, N. Y.

COMBINATION COMPRESSOR AND VACUUM PUMP—Which is convertible, and includes novel lubricating means. Patent 1478929. C. M. Tursky, 306 W. 56th St., New York, N. Y.

SILENT KEY TYPEWRITER ATTACHMENT—Which may be attached to any form of typewriter. Patent 1478600. L. Cardoso, c/o Lazard Freres, Cie., 120 B'way, New York, N. Y.

DRAG SAW—The accidental movement of which is prevented while the device is in action. Patent 1478573. R. H. McDonald, Scio, Oregon.

ATTACHMENT FOR HEMSTITCHING MACHINES—Which may be used for forming picot edges. Patent 1478379. F. and H. Burgert, 51 W. 29th St., New York, N. Y.

OIL WELL EQUIPMENT—For preventing sand in the oil from lodging between the plunger and the working barrel. Patent 1479208. R. D. Thompson and J. Penrod, 1241 E. 9th St., Okmulgee, Okla.

GARMENT MEASURING DEVICE—Whereby a skirt may be arranged to hang at a desired level. Patent 1479119. J. Vrana, c/o Geo. B. Efantis, Route 2, Hinsdale, Ill.

MOUNTING FOR SEWING MACHINE HEADS—That may be easily moved from place to place for sewing filled bags. Patent 1480457. J. F. Martin, 66 Exchange St., Pawtucket, R. I.

SAFETY CONTROL DEVICE—For the cable drum of a hoister, which will automatically bring the drum to a stop. Patent 1480170. H. H. Logan, 1765 Winnemac Ave., Chicago, Ill.

SAVE-ALL—For separating the pulp fibers from the waste water, from paper-making machines. Patent 1480500. G. W. Brown, c/o W. E. Rosebush, c/o Inland Empire Paper Co., Millwood, Wash.

MACHINE FOR CUTTING OFF AND THREADING PIPES—Which may be operated by power or by hand. Patent 1481191. T. V. Elliott and C. Schaefer, New Brunswick, N. J.

POLISHING DEVICE—By which metal plates may be cleaned and polished by a single machine. Patent 1481242. J. J. Mueller, Jr., c/o Superior Metal Co., Bethlehem, Pa.

PLASTIC MOULDING MACHINE—For forming hollow building blocks, whereby the coress side and end walls may be conveniently removed. Patent 1481686. J. F. Caldwell, 2722 No. Broadway, Los Angeles, Calif.

SLAUGHTERING DEVICE—With means for thrusting a knife with tilting motion into the animal's body. Patent 1480197. R. W. Cudworth, 1144 Leavenworth St., San Francisco, Calif.

SLIP—Especially adapted for use in oil well operations. Patent 1481378. G. F. Le Bus, c/o Le Bus Rotary Valve Co., Electra, Texas.

CENTRIFUGAL SEPARATOR—Providing a machine adapted to concentrate solid matters suspended in liquids. Patent 1481426. F. W. McEntire, Hotel Utah, Salt Lake City, Utah.

SWITCH MOUNTING FOR MACHINES HAVING INDIVIDUAL MOTORS—More particularly for use in connection with knitting machines and the like. Patent 1481280. J. P. Bivens, Gastonia, N. C.

BEARING—In which friction is reduced to a minimum, with elements which may be renewed when worn. Patent 1481705. M. G. Gimeno, 17 Cottage St., Bayonne, N. J.

BELT CALCULATOR—With scales for calculating the stretch of known lengths. Patent 1481702. G. R. Fickert, 611 Bloomfield St., Hoboken, N. J.

PITMAN OILER—Intended to prevent overheating in the pitman of a mowing machine. Patent 1481918. J. F. Lowe, Oconomowoc, Wis.

DISPLAY DEVICE—Comprising mechanism for rotating and displaying continuous various articles. Patent 1482332. F. Weren, 196 Palisade Ave., Jersey City, N. J.

ADJUSTABLE CHUTE SPRING FOR TYPE-SETTING MACHINES—Which may be easily associated with all standard forms of type-setting machines. Patent 1483017. R. Shields, 500 Coney Island Ave., Brooklyn, N. Y.

HACKLING MACHINE—Wherein fiber may be secured from the palmetto boots, jackets, leaves, and stems by one operation. Patent 1483034. L. B. Wootton, c/o Baldwin & Velter, Law Exchange Bldg., Jacksonville, Fla.

GRIPPER FOR PRINTING PRESSES—By means of which each finger is given a resilient gripping action independently. Patent 1483057. A. W. Warsen, 31 Ashford St., Hartford, Conn.

PROJECTING MACHINE—Which is readily portable and especially adapted for use in connection with illustrated lectures. Patent 1483025. G. M. Tucker, Jr., Box 747, Albany, N. Y.

Prime Movers and Their Accessories

COOLING MEANS FOR INTERNAL COMBUSTION ENGINES—Providing means whereby air may be circulated through a housing, positioned about the engine. Patent 1479412. H. N. Harper, Kidd Bldg., Ruston, La.

CAM-FOLLOWER GUIDE—To prevent a cam follower from pumping oil through the guide. Patent 1479735. V. W. Page, c/o Victor Page Motor Co., Melrose Ave., Stamford, Conn.

CARBURETOR—With means for automatically scavenging the engine cylinders at any desired time. Patent 1480478. G. H. Taber, 2719 1/2 Baldwin St., Los Angeles, Calif.

ROTARY GAS ENGINE—In which the power developed is imparted without the necessity of the usual crank shaft. Patent 1481220. E. R. Nichols, 5510 Blackstone Ave., Chicago, Ill.

FUEL MIXER—By means of which it will be possible to obtain a more perfect combustion. Patent 1481118. R. L. Bennett, 410 E. 143rd St., Bronx, New York.

TIMER—Which may be readily applied to a Ford engine, without altering the construction of the same. Patent 1481950. W. A. Ashley, 615 1st St., Liverpool, N. Y.

Railways and Their Accessories

SHIFTING APPARATUS—Having means for lifting a car clear of the tracks and carrying it to an unloading platform, without interfering with traffic. Patent 1479767. J. J. Wolf, 230 Mechanic St., Boonton, N. J.

SLIDING DOOR SUPPORT—Adapted for use in connection with freight cars, and the like. Patent 1480641. F. Tetzlaff, c/o Konnoson & Konnoson, 174 Broadway, New York, N. Y.

FREIGHT-CAR DOOR—Particularly adapted for use in loading or unloading grain or any loose bulk commodity. Patent 1482307. K. R. Koskinen, c/o Finnish Book Co., 4308 8th Ave., Brooklyn, N. Y.

Pertaining to Recreation

TOY MACHINE GUN—Which is simple in construction and durable in use. Patent 1480499. A. R. Brown c/o E. W. Brown, 426 So. 4th St., Louisville, Ky.

TOY ELECTROSTEAM ENGINE—In which the steam is generated by means of an electrically heated unit. Patent 1480445. S. D. and W. E. Horlacher, Tunkhannock, Pa.

TOY—Comprising a propelling ball loosely fitting within a cylindrical body, which may be drawn over the floor. Patent 1481227. C. Ridderhof, Times Building, 42nd St., New York, N. Y.

TOY HELICOPTER—This inventor has been granted two patents of a similar nature, in which the propeller action of the toy is by means of a twisted rubber band. Patents 1481826, 1481827. L. W. Brown, 106 E. Clinton St., Clinton, Missouri.

Pertaining to Vehicles

PISTON RING HOLDER—Especially adapted for use when inserting pistons into cylinders. Patent 1478724. C. Barchus, Room 6, Lowenburg Bldg., Natchez, Miss.

SHOCK ABSORBER—Formed by a coil spring clamped between the cantilever and semi-elliptic springs. Patent 1477959. R. D. Hughes, c/o Red Giant Tool Co., Box 114, Lynchburg, Va.

DIRECTION INDICATOR—With means for actuating the same from the steering post. Patent 1478916. E. L. Robinson, 315 S. Hewitt St., Los Angeles, Cal.

AUTOMOBILE PERISCOPE—Which enables the operator to obtain a vision of objects in front or behind. Patent 1478650. L. Hallengren, c/o J. R. Leppo, Atty., Bank of Italy Bldg., Santa Rosa, Cal.

WHEEL FOR AUTOMOBILES—Of the demountable type, which may be easily assembled. Patent 1478437. S. Kaplan and H. M. Howell, Monroe, La.

LUBRICATING SYSTEM—Comprising means for supplying lubricant to bearings, and like parts. Patent 1478513. P. H. Gaskins, 1207 Graham Bldg., Jacksonville, Fla.

DEMOUNTABLE ATTACHMENT FOR TRACTORS—Whereby heavy articles may be transported in the same manner as by a truck. Patent 1479422. J. F. Bailey, 819 Maple St., Columbia, S. C.

SIDE FRAME BRACE AND RADIATOR SHELL—Particularly adapted to a chassis structure in which the motor is of the air-cooled type. Patent 1479734. V. W. Page, c/o Victor Page Motor Co., Melrose Ave., Stamford, Conn.

EXHAUST MUFFLER FOR MOTOR CARS—With means for reducing the back pressure upon exhaust gases passing therethrough. Patent 1479714. F. J. Herdle, 1847 W. Huron St., Chicago, Ill.

VEHICLES—With shock absorbing means in the form of cylinders and coiled springs. Patent 1480279. W. B. MacLachlan, 3246 2nd Ave., So. Minneapolis, Minn.

CURTAIN SWING—Providing a hanging arm whereby the curtain can be swung to leave an open doorway. Patent 1480493. J. Z. Benson, Box 43, Station "A", Marshallton, Iowa.

Designs

DESIGN FOR A BUILDING TILE. Patent 63264. Q. Monier, Box 411, Tucson, Ariz.

DESIGN FOR A BATHING SUIT CASE. Patent 63496. J. Schacht, 54 E. 121st St., New York, N. Y.

DESIGN FOR A CHANDELIER. Patent 63577. A. Miller, c/o Radiant Lighting Fixture Co., 33 Bleecker St., New York, N. Y.

DESIGN FOR A TIRE TREAD—Patent 63578. L. G. Nassoioy, 921 Cleveland Ave., Niagara Falls, N. Y.

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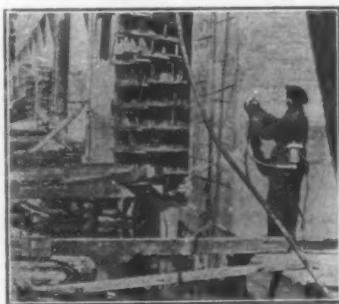
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Electrical

Motion Pictures Aid Testing Staffs.

It has become increasingly evident during recent months, says *Electrical World*, that motion pictures have a utilitarian value to engineers as technical keys for unlocking many doors to increased efficiency in investigation and operation. One of the most recent applications of such pictures is to record simultaneously the readings of many indicating meters. In machine or plant tests requiring the accurate and simultaneous readings of many instruments much difficulty has been experienced because of the limitation of time, the number of readings required and the inaccuracy of readings made in a hurry by human observers. By the use of motion pictures it is possible to arrange the meters in a manner to expose the dials to the camera and to obtain a continuous and accurate series of records which can be read and interpreted at any later time in a leisurely manner. In power stations, research and test laboratories and industrial plants this new tool for testers is sure of a welcome, and a little study shows a multitude of other engineering applications of a similar character where it can advantageously be employed.

Power Transmission Without Wires.

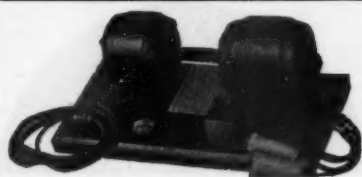
Commenting on the subject of the high potentials brought about in transmission lines by lightning discharges, E. E. F. Creighton of the General Electric Company makes a detour over what he apologetically characterizes as dangerous ground—the fascinating problem of power transmission without wires. The proposition contains some attractive figures. For example, the distance up to universal conductance all around the 25,000-mile circumference of the earth is only a few miles, while it is 3,000 miles from San Francisco to New York. The outer conducting envelope of the earth might be fed with electrical energy at any number of points where huge hydraulic power is being wasted and suitably tapped anywhere in civilization where it can be utilized. Immediately there flashes forward the great advantage of using in New York and Chicago the waste power pouring over Victoria Falls, Africa. Attractive the thought, also, to save millions of tons each year of the limited supply of the world's coal. "Why not?" asks the dreamer. There is a close connection between the subject of atmospheric high conduction and direct lightning strokes. The desire is double-barreled—the first barrel is to bait an encouragement in the study of lightning phenomena in its most interesting phase, the highly conducting stream; the second is to point out how little we know of it. Who knows but that a study of the lightning bolt which travels miles through an insulating atmosphere may not reveal a method of reaching the conduction of the upper atmosphere? Stranger things have taken place in research. As practical matters stand now, A. B. Hendricks has reached two million volts in designs of power transformers. How many more million will be necessary to reach from a super-Eiffel Tower on a mountain top through a captive balloon to a high conducting layer? Incidentally, an oscillator at a half-million volts will send out luminous conducting streamers longer than one's arm, which waves around in the air and ends, not in a conductor, but apparently in invisible nothingness. It is startlingly suggestive.—*Electrical World*.

Swedish Method of Impregnating Telegraph Poles.—The spawn of the fungi which produce dry rot in wood require for their growth a suitable degree of moisture and access to the oxygen of the air. Their maximum development takes place at 18 per cent of moisture in the wood, and the growth decreases at both a lower and a higher percentage. The top of a pole may often get as wet as this, but it dries too

soon for the fungi to get to work. The bottom is apt to be constantly wet, but too wet for the fungi. But there is generally a point between these two parts at which the correct amount of moisture, 18 per cent, remains fairly constant, and this is the zone where the fungi do their "dirty work." One apparently good way to get around this difficulty would be to fill this zone with loose stone. To do this would be merely to transfer the inevitable zone further down the pole. Tarring this part of the pole is unsatisfactory, for the tar does not penetrate the deep cracks as does creosote where impregnating has been done under pressure. In fact, tarring may hold water in, thus acting as a detriment. A new process has been used in Sweden during the past four years. The poles are charred with a special torch. This protects the surface, for there is no nourishment for the fungi in the charcoal on the surface. In addition, charring opens every crack that will ever open, and temporarily opens them wide. This permits a creosote spray to reach the interior of the pole. Later, they close, or partly close. The charcoal, being porous, absorbs more creosote than does wood, and this gradually soaks in and spreads. The method has been very successful in Sweden, Norway, Denmark and Finland.—*Electrical World*, 83:8, 3 pp., ill.

A Telephone System for Europe is a project that is now receiving considerable attention. No doubt the Europeans are inspired by the excellent Bell telephone system which covers the United States with such thoroughness that one subscriber can reach any other subscriber, no matter what the distance may be. While admitting the desirability of establishing a network of underground cables for international telephone services, it has been decided, for the present, to regard 1000 miles as the limiting distance for lines consisting of cables only and to employ aerial lines in cases where greater distances are involved. Repeaters of the vacuum tube type will be used on both aerial lines and on cables, and special consideration is to be given by the various administrations represented at the conference to the regulations required to protect long-distance telephone lines from disturbance by electric power transmission systems. The appointment of a permanent committee, representing all European countries, for the purpose of maintaining continuous cooperation, and the establishment of a small permanent secretariat to act on behalf of the committee and to facilitate the exchange of technical information, are other items in the recommendations of the conference.

Piezo—Electricity of Rochelle Salt Crystals.—Some time ago we carried in our columns an account of the so-called "speaking" crystals, which are nothing more than rochelle salt crystals that display strong microphonic characteristics. The effect varies with the treatment of the crystal and is very marked when the crystal is dried in alcohol and baked. For this purpose the crystal is dried in 90 per cent alcohol for 24 hours and in 100 per cent alcohol for about four hours, and then baked at 40 degrees C. for several days. A twisting couple about the principal axis excites the greatest electrification. A crystal on a phonographic record will generate several volts, with sufficient power to operate a large number of telephone receivers. As many as 200 receivers, each of 12,000 ohms impedance, have been operated from one crystal. By means of a vacuum tube amplifier, very good transmission of speech may be obtained by using such crystals at both ends of a long as the sole transmitting and receiving apparatus. It is rumored that a loud-speaker based on these speaking crystals is soon to appear on the market.—*Facts from Faraday Society Transactions*.



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General

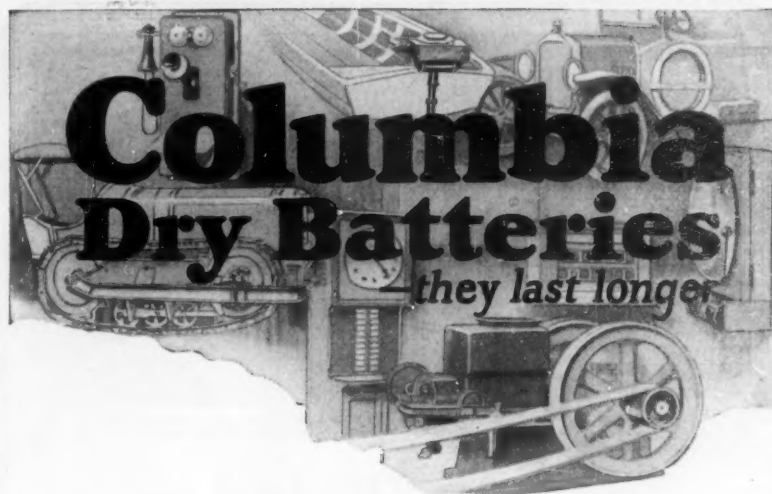
The Demand for Tacks has passed through periods of wide fluctuation due to changes in style and to new inventions and new customs. Some 30 years ago carpets were used extensively and the demand for tacks was heavy. The increasing use of rugs in place of carpets, however, caused a falling off in the tack industry. But rapid progress in the production of automobiles soon developed a new field for tacks. Variations in furniture design constantly are causing fluctuations in tack demand. The shoe industry always has been one of the chief outlets for tacks, but even here changes in design cause a variation in the number of tacks used. The rubber heel industry has shortened the average length of heel tacks by nearly 50 per cent. General household demand for tacks has remained fairly constant throughout the last 10 or 15 years, and this accounts for a surprisingly large proportion of the country's production. The country's tack supply is turned out by a relatively few manufacturers, about 30 plants, and the machines which are used are made by not more than three or four companies.—*Iron Trade*, 74:13, 5 pp., ill.

Fuel Economizers are designed on the principle of admitting pre-heated air over the top of the fire. Usually these consist of some sort of a coil or box to be attached to the door of the furnace, on the inside. The air that enters them is heated by the fire before it issues through a number of small openings. Concerning devices of this sort the Bureau of Mines states that when coal is put on a hot fuel bed, and there is a rapid evolution of volatile matter, supplementary air is needed, and it might be even desirable to keep the firing door open for a few moments to supply this air. It is conceivable that such supplementary air might be more advantageously admitted nearer the surface of the fuel bed in finer streams and pre-heated. In most firing, however, this condition lasts for a relatively short time during the whole 24 hours, and the Bureau believes that in most cases the efficiency would be reduced by too much supplementary air rather than by too little. If there were any lack of supplementary air, it would be shown by the presence of carbon monoxide in the flue gases. Technical paper No. 303 shows that in tests made by the Bureau, the amount of carbon monoxide is extremely small, or none at all. The heat carried away by dry flue gases is an appreciable amount, so that if we add to these dry gases they can be expected to carry away considerably more heat. The Bureau states that it cannot advocate these devices, at least where applied to small household heating plants.

Carbon Monoxide Fatalities from Natural Gas Heaters is the subject of an analytical study, made by the Bureau of Mines and detailed in Serial 2572. The Bureau has not found any case where fatalities have resulted from natural-gas heaters in which the heaters were connected to a flue or set in a fireplace from which the products of combustion could be carried off through the chimney to the outside. It was found that the rooms were, with one exception, tightly closed, and in many cases the cracks sealed up with weather stripping. It seems that even if a heater liberates carbon monoxide, fatalities are not likely to occur if the heater is connected to a flue and one or more doors and windows are partly open. This precaution is especially necessary if a heater is allowed to burn in a room in which people sleep. In fact, no one should sleep in a closed room in which any natural-gas heater is burning. In some cases the rooms were of large size, having more than 1700 cubic feet capacity. The fact that a room is of large capacity does not ensure that all natural-gas heaters can be safely used in such rooms, unless the heater is properly vented to a flue. The main glaring cause of liberation of carbon monoxide is due to excessive gas flows arising from too large gas orifices. Adjustable orifices are dangerous unless limited to such a size that excessive gas flows can not be obtained even at the maximum gas pressure available in the locality where used.

Automotive

The Automotive Fuel Problem.—Recent advances in the design of gasoline engines have had fuel economy as the goal. It is quite possible that the engine of tomorrow will double the miles obtainable from a gallon of gasoline. This result can be accom-



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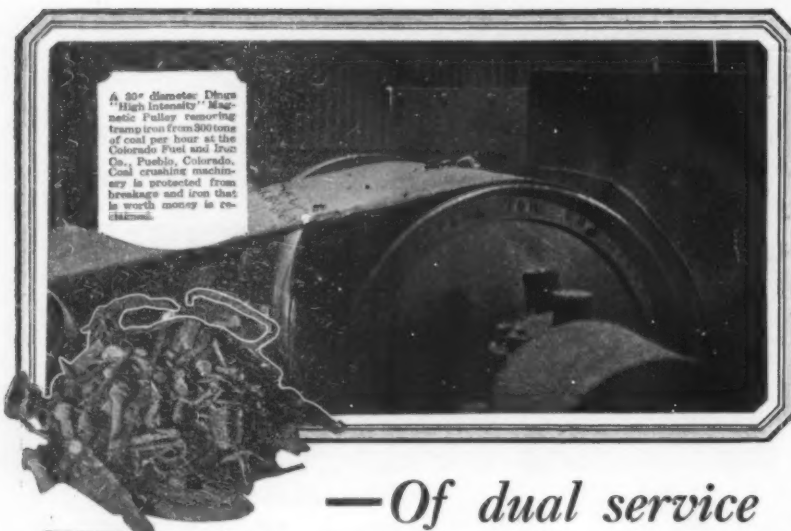
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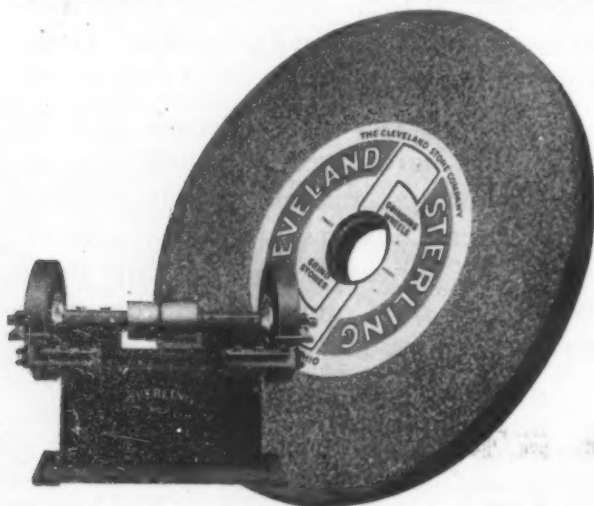
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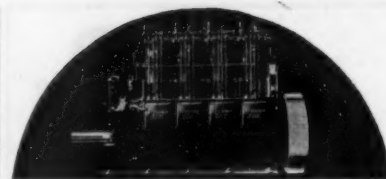


plished by (1) increasing the compression of the fuel charge and (2) by increasing the average percentage operating load on the engine. Although increased compression ordinarily produces "fuel knock," the successful development of "anti-knock" substances within the past few years makes possible the use of very high compressions without incurring any ill effects. The percentage operating load may be increased simply by the introduction of more forward speeds of high gear ratio, actuated by suitable automatic gear selectors. In this latter practice, Europe has been somewhat ahead of us for a number of years. In brief, then, it is entirely within reason to predict that by 1934 we shall have exhausted one-half of the petroleum available from wells. Our importations of oil will be of great magnitude. A new and important industry, that of winning oil from shale rock, will be on a firm commercial basis. Automobiles, although more than double in number, will be much more economical of fuel and as a result, the cost of operation per mile is not likely to be any greater than at present.—*Tech. Eng. News*, 5:1, 2 pp.

Automobilism in the United States is the title of a revealing article in *The Auto-car* (see No. 1481). Here we get a look at ourselves as an Englishman sees us, automotively, as it were; and the great majority of aspects of American motoring seem to have pleased him. Referring to New York, after praising the "clean, smooth running taxis," he says traffic congestion is so severe that in the busy parts of the city during the daytime it takes longer to go anywhere by taxi than on foot. The traffic problem is serious but has been tackled in an admirable manner. Practically no walkers cross from side to side of the streets. Streets in New York and other large cities are generally very well kept. On the other hand there is liable to be very rough going due to repairs, raised tramlines and bad pot-holes. There is undoubtedly a better average surface than in English town streets, except for certain bad bits which are so bad that the springing on not a few British cars would be hard put to it to withstand them. All main roads in the East and Middle West are uniformly good. By-roads are generally bad. The marking of roads is well carried out as regards signposts. Service stations are generally neat and tidy. Most American cars are black, and seen generally as a procession, they give the impression of many hearses in a row. The average American car is powerful, quiet and sweet running. The better class cars compare well with British cars as regards durability. The weather conditions are such that a car does not keep its looks as long as in England. The buying of cars on the installment plan is very common, and there are many banks which deal solely with such business. Here are a few brickbats, perhaps deserved ones; but many bouquets.

Mudguard Efficiency.—By far the loudest grumble which one hears about mudguards concerns the edge of the wing round which mud creeps in considerable quantities, subsequently to fly off and cover the sides of the body, or even the rear passengers. It is curious to find many of even the very large and expensive cars with singularly inefficient mudguards, and the point is that a very good guard can be made by curling the edge of the metal over to form a trough which conducts the mud downwards beneath the running board. There are four, possibly five, British manufacturers who have adopted this device, and, incidentally, one of them uses the same type of mudguard for the least expensive chassis produced. Not only does this gutter prevent mud creeping round the guard, but it also stops the edge of the metal from splitting.—*Autocar* (see No. 1482.)

A New Airplane Launching and Landing Device.—The chief advantage of commercial aviation is its ability to carry goods, or passengers at a greater speed than that afforded by the present methods of transportation. However, much of this advantage is lost at the present time because of the time lost at the terminals in getting from the landing field to the city. As an example, a person coming into New York City by the air line would land at one of the fields near Garden City. He would then have about a two mile ride in a taxi to the nearest railroad station and a twenty mile ride by train to the city, thus losing most of the time gained en route. An interesting solution to this problem is offered by a Brooklyn, N. Y., manufacturer through the



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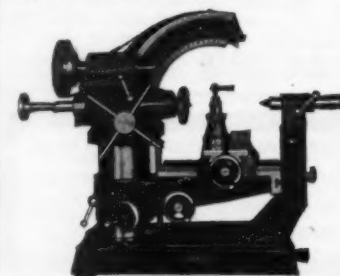
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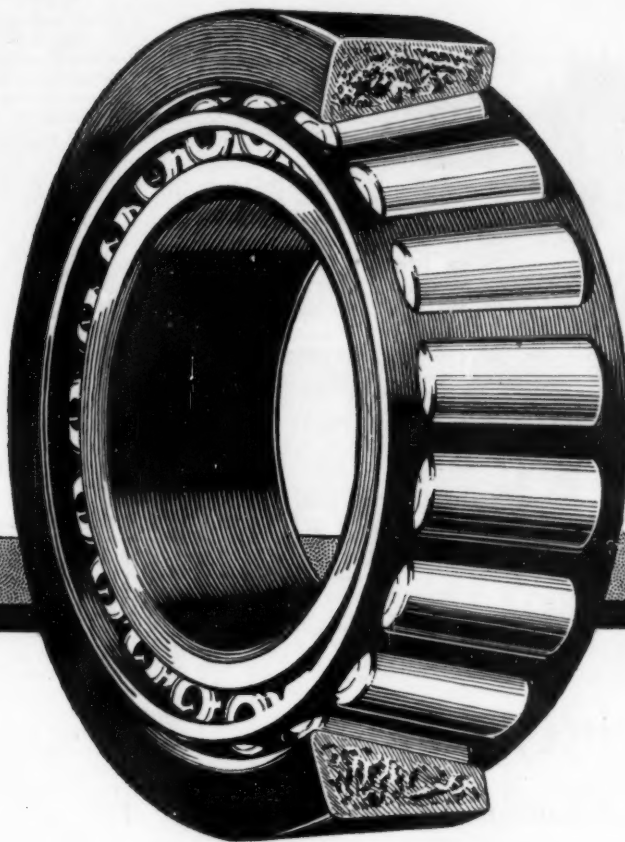
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development of a device for landing and launching airplanes in restricted areas. Briefly, the device consists of a flat, unobstructed platform made up of wood flooring on a light structural steel frame-work. This platform is pivoted transversely in the center to allow it to be tilted to any desired angle and is mounted on a circular track similar to a turntable or turret, allowing it to be revolved into the wind for the launching or receiving of airplanes. The surface of the platform is fitted with various devices for slowing up the plane. The size of the platform is determined by the weight and landing speed of the planes it is to handle, the smallest dimensions being about 60 feet wide and 175 feet long. Structurally the device is similar to other steel structures and offers no new engineering problems. Electrically and mechanically also it is merely a new application of old ideas. All the movements of the platform are made electrically and under the control of an operator located in a pilot house at one corner of the platform. All controls are in duplicate. The platform is also completely equipped with lights for night flying, including flood lights, beacon lights and various signal lights.—*Aviation, 16:12, 1 p.*

Braking on Four Wheels conclusively proved its advantages from the standpoint of rapid deceleration in tests staged in Washington last week by the Washington Section of the Society of Automotive Engineers working in cooperation with the Bureau of Standards. Of the fourteen cars which participated in these tests, ten had four-wheel brakes and the remainder two-wheel brakes only. Tests were made at 20 and 30 miles per hour on dry asphalt paving, and at 25 m.p.h. on the same surface washed clean and still wet. In the tests on dry pavement, the four-wheel brake cars showed an average deceleration rate of 20.9 feet per sec. per sec. as against 11.1 per sec. per sec. for two-wheel brake cars. On wet pavement the corresponding figures were respectively 17.5 and 8.2 per sec. per sec. Expressed in terms of equivalent stopping distance from an initial speed of 20 m.p.h. the average figure for four-wheel brake cars on dry pavement was 21.1 feet and on wet pavement, 26.8 feet. Corresponding figures for two-wheel brake cars were 36 and 53.3 feet respectively.

The Dangerous Fallacy that the atmosphere in a closed garage is safe as long as an automobile engine continues to function has been disproved by a test conducted by engineers of the Bureau of Mines. An ordinary touring car of popular make, which is operated daily, was placed in a brick garage having a capacity of approximately 3000 cubic feet, a dog was placed upon the driver's seat, and the engine allowed to continue running at an idling speed, which is much slower than the average motorist would use for "warming up" purposes. The doors of the garage were closed, and after 20 minutes operation of the engine, the dog lost consciousness and fell to the floor of the car. An analysis of the air at this time disclosed the presence of 1.3 per cent of carbon monoxide, which is sufficient to cause unconsciousness and death in a few minutes. The automobile engine was allowed to run until it stopped from lack of air, which occurred at the end of two hours, when the percentage of carbon monoxide present in the garage atmosphere was indicated as 2.1 per cent, an almost instantaneously fatal amount. The engine functioned six times as long as the dog retained consciousness, proving conclusively that the continued operation of an automobile engine in a closed garage is no indication as to the condition of the air and that the engine will continue to function long after the operator has lost consciousness. This experiment was conducted in a garage several times as large as the average one-car garage and it is safe to assume that a dangerous concentration of carbon monoxide would result in a one-car garage in less than half the time recorded in this experiment. In other words, the dog would have lost consciousness in about ten minutes after the starting of the engine, which would have continued running for about one hour. The Bureau of Mines calls attention to the great danger of anyone entering a closed garage for the purpose of shutting off a running engine. This frequently happens on occasions when a motorist starts his engine and leaves it running while he returns to the house for something he has forgotten. It is quite certain under such conditions that dangerous concentration of carbon monoxide will occur in a very



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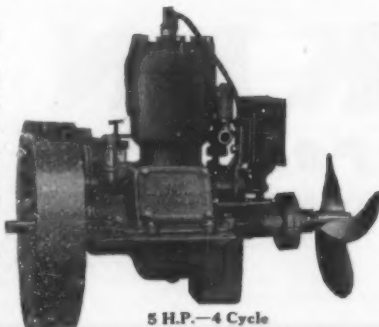
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short time if the garage is closed and when the motorist returns he is likely to encounter an atmosphere sufficiently charged with carbon monoxide to render him unconscious in two or three minutes and to cause his death if he is not promptly rescued.

Internal Losses in Motors vary with the speed and a large number of interesting considerations of this matter are discussed in *Automotive Ind.* (50:10, 3 pp.). A friction horsepower curve is obtained by "motoring" the engine by means of an electric dynamometer, the torque on the field frame of the dynamometer then indicating the friction torque. The test can be made in a number of different ways. Ordinarily the engine is completely assembled and is "motored" with the throttle wide open. The torque measured under these conditions represents both the various mechanical friction losses and the so-called pumping losses. By pumping losses is meant the losses occasioned by gas pressure on the piston contrary to its direction of motion. In order to eliminate the pumping losses in friction horsepower determinations it is customary to remove the valves and valve plugs (if the latter are used) as well as the spark plugs. Atmospheric air can then follow the motions of the pistons without appreciable resistance and practically all pumping losses are eliminated, leaving only the losses due to mechanical friction. A very extensive series of tests was made on a Pierce-Arrow six-cylinder engine. The engine was "motored" both completely assembled and with the throttle wide open, and with all of the valves and plugs removed from the cylinders. There was a material difference between the torques required to turn over the engine under these two conditions, and this represents the torque due to the pumping losses. This difference in torque amounted to 8.4 pound-feet at 470 r.p.m., 16.4 pound-feet at 1000 r.p.m., and 29.5 pound-feet at 1700 r.p.m. It will be seen from these figures that the pumping loss torque is very closely proportional to the speed. It would appear that the flow of the charge through the carburetor is largely a streamline flow.

The Trend of Automotive Advance is generally foreshadowed in the publication, *Automotive Industries*. Most matters pertaining to the motor car are discussed by the personnel of the industry one or two years in advance of their adoption. Theories are threshed out; experiments are described and interpreted; failures of specific types of devices are detailed. In short, like all industries, the automotive industry, with some regrettable exceptions, looks before it leaps, and the intelligent reader is placed in a somewhat similar position to get a forecast of what motor cars will be like a couple of years hence that a sitter-in at a tailor's national convention would be to know whether trousers will or will not have cuffs in 1926. When it comes to the theory of design of this or that part of a car, however, long study and trial tests take the place of the whims that govern the choice of trouser cuffs. Reading of this sort is, however, neither as exciting as reading a Nick Carter novel, nor so elementary that the non-mathematically educated ash collector can follow it with vast satisfaction. In another publication, *Tires*, one gets rather a different slant on some matters than one finds in the general press. For instance, the low-pressure tire seems to be regarded by some members of the industry as a by-no-means-sure-to-stick innovation. There is a feeling that this kind of tire was put on the market a little too soon, and that the dissatisfaction of some users of so-called "balloon type" tires is in danger of overtaking the advance of the real balloon tire. If another year had been let pass before the new tires were put out, everything would have been ready to "go the whole hog" instead of making a compromise that is not nearly as satisfactory as the full balloon tire. Will the compromise tire fatally injure the chances of the real balloon? Some members of the industry seem worried.

A Diesel-engined Motor Truck is now on the market in Germany. The engine works on the true Diesel cycle, using a compression pressure of slightly over 500 pounds per square inch, the fuel charge being ignited by heat generated by the compression of the air. No air compressor plant for injection purposes is used. There is an ignition chamber on top of the cylinder, in which a small quantity of the fuel ignites spontaneously and forces the rest of the fuel into the combustion chamber in the form of a very fine

spray. It is claimed that this engine can be operated on any heavy fuel such as crude oil; that the engine can be idled for any length of time and that it will carry a full load immediately after an extended period of idling. In external appearance this power-plant does not differ materially from the conventional truck engine. The individual cylinders have both the inlet and the exhaust valves in the head, which are inclosed under an aluminum cover and operated by outside pushrods. The ignition chamber is arranged between the two valves. As is customary in engines of this type, the cylinder heads are cast separately. Starting of the engine is effected in two stages and usually by means of the electric starter. During the first stage the exhaust valves are lifted off their seats by means of a hand lever. The starting motor then cranks the engine over rapidly and the flywheel accumulates momentum. After a sufficient speed has been attained the exhaust valves are released by the hand lever, but they are prevented from closing entirely by small auxiliary cams. Not sufficient heat is developed by the compression during this stage of the starting operation to ignite the charge spontaneously, and ignition is effected by means of an ignition plug which carries a filament which is maintained in an incandescent state by means of current from a storage battery. After the first ignition the camshaft is shifted axially into its normal working position, whereby the auxiliary cams are put out of action and the current is cut off from the ignition plug. Thereafter ignition takes place entirely automatically. The engine has four cylinders of substantially 5-inch bore and 7½-inch stroke, and is claimed to develop 50 horsepower at 1000 r.p.m. The fuel consumption is given as 0.53 pounds per horsepower-hour. —*Auto Ind.*, 50:10.

Saving Helium for Dirigibles.—Since airships were first flown one of the difficulties encountered by every pilot has been that of keeping his ship at or near static equilibrium or at a constant altitude. As fuel was burnt out the ship grew lighter in weight and tended to rise. This rise caused the gas in the cells to expand and sooner or later it was necessary to release gas in order to bring the lift of the contained gas back to equality with the weight of the ship. Pure gasoline consists entirely of hydrogen and carbon in several related combinations, but when it is burned, either in an engine or as a flame, the carbon combines with some of the oxygen of the air to form carbon dioxide and the hydrogen, taking the other part of the oxygen, forms water. This water is at first in the form of a superheated steam but quickly cools and appears as droplets of hot water on the walls of any long exhaust pipes. On any very cold morning you may see its white plume at the exhaust of every automobile muffler. The Navy has developed a method of condensing this vapor and thus obviating the necessity of continually valving off gas in order to compensate for decreased weight due to consumed gasoline. This apparatus occupies a space above the car which is roughly a five-foot cube. It consists of many small aluminum tubes in which the exhaust gases are to be cooled and gradually give up the water which they contain. Running into a sump in the car this water will be pumped up into the ballast bags in the keel and thus balance the loss of weight due to the burning out of fuel. The exhaust of a gasoline engine, in other words, discharges about 1.4 pounds of water for each pound of gasoline consumed.—*U. S. Air Services*, 9:3, 2 pp.

Metallurgy

Oxygen-enriched Air in Metallurgical Work.—The first serious attempt to use enriched air in metallurgical work was that made by the Belgians at Liège in their small iron blast furnace. While the detailed results of these experiments were not made available to the general public, and the outbreak of the war put an end to the experiments, nevertheless a certain amount of information is at hand. The slightest introduction of oxygen into the air blast made itself felt, a fraction of 1 per cent overcoming detrimental effect of the moisture of the atmosphere. An increase of oxygen content from the normal 20 per cent up to approximately 24 or 25 per cent made it possible to dispense with the hot-blast stoves and produced a higher grade iron. The second comprehensive experiment in the use of oxygen in large-scale metallurgy took place some years ago just over the boundary line, in

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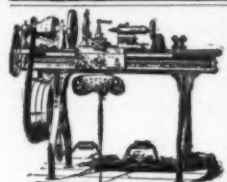
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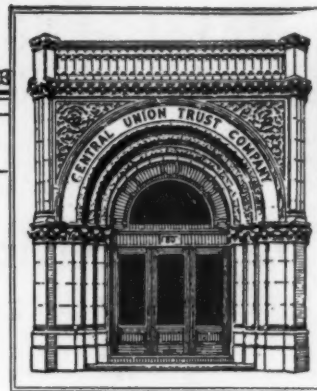
Canada. It was an attempt made by a well known iron metallurgist of this country to produce ferrosilicon of high silicon content in a shaft furnace. A prominent metallurgist states that he does not believe the use of oxygen is suddenly going to revolutionize metallurgical practice. We are going to take standardized apparatus, well known as to peculiarities and of which we are completely informed as to constants, and slowly and carefully and step by step, through the introduction of oxygen build up a set of experimental data, revising our equipment as to details on the basis of our new knowledge and, without appreciable break from sequence, develop from our present to the new practice. There is, however, one important possibility in the metallurgy of the non-ferrous metals that must not be overlooked, and that is in the preliminary roasting operations. It is believed that the judicious use of enriched air in roasting will greatly simplify the operation. It will suddenly lower the grade of self-roasting ores, thereby eliminating the use of external fuel, and should at the same time yield a more completely dead-roasted product.—*Iron Age*, 113:12, 1 p.

A New Process for the Production of Sponge Iron has been developed by the Department of the Interior, in cooperation with the University of Washington, as the result of experimental work conducted during the past three years at the Northwest experiment station of the Bureau of Mines, Seattle, Wash. Sponge iron, because of its porous structure and consequent exposure of an extremely large surface of metallic iron, is especially adaptable to the precipitation of copper, lead, and other metals from their solution. The development of a process by which sponge iron may be made cheaply from iron ore and low-grade coal and afterwards converted into iron and steel products by treatment in the electric furnace would be of especial economic importance to the Pacific Coast region of the United States, a territory remote from the larger iron and steel producing centers, but endowed with cheap electric energy to take the place of the expensive coke that would otherwise have to be utilized in iron and steel production. On account of the removal of oxygen from iron oxide ore, the structure of sponge iron is very porous, an extremely large surface of metallic iron being exposed. As a result, sponge iron is an active reducing agent and precipitates metals from solution with greater speed than do the more massive forms of iron, such as steel scrap and iron turnings. The Bureau of Mines considers that sponge iron will probably be used extensively for the precipitation of copper, lead, and other metals from hydrometallurgical solutions. The many advantages afforded by the use of sponge iron for this purpose should cause an expansion of processes involving leaching and precipitation. In the process developed by the Bureau of Mines and University of Washington investigators, almost any type of iron ore is satisfactory for the production of sponge iron. Experiments conducted showed that similar results are obtained with magnetite, hard and soft hematite, limonite and sintered hematite. It is probable that sponge iron will be made from such by-product materials as flue dust, pyrite cinder, various slags of high iron content, and iron oxide sludge. The Bureau of Mines process consists in passing a mixture of iron ore and coal through a rotating kiln heated at one end to a temperature sufficient to convert iron oxide to metallic iron, discharging, cooling, and separating the sponge iron from the residual coke and siliceous material on a magnetic separator. Details of these experiments are given in Serial 2578, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Two New Alloys have been introduced in aircraft engine construction by the Engineering Division of the Air Service, McCook Field. One is a light structural alloy containing 93 per cent magnesium, 5 per cent aluminum and 2 per cent zinc, and is used for the crankcase of a W-type aircraft engine, resulting in a saving in weight of something like 200 pounds as compared with the aluminum alloy containing 8 per cent of copper, which was previously used. The other alloy consists of aluminum, copper, nickel and magnesium, and while the formula is not new, being of the duralumin class, the heat treatment has been improved and increased mechanical qualities secured as a result. One of the valuable properties of this alloy is said to be that it retains its

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strength at high temperatures, which is of value because it is used principally for such parts as engine cylinders, pistons, cylinder heads and manifolds.—Auto Ind.

Vanadium is one of the most useful of the rare metals, states J. E. Conley in Bulletin 212, recently published through the Bureau of Mines. The chief deposits of vanadium, by far the most important in the world, are at Minasragra, Peru. In the United States the largest deposits are in San Miguel County, southwestern Colorado. From 200,000 to 300,000 pounds of vanadic oxide is probably produced annually as a by-product in the extraction of radium. Vanadium is used chiefly in steel for purposes requiring great toughness and torsional strength, such as automobile parts, gears, piston rods, tubes, boiler plates, transmission shafts, bolts, gun barrel, gun shields, and forgings that have to withstand heavy wear and tear. The vanadium content of such steels ranges from 0.1 to 0.4 per cent. Vanadium is also used occasionally in certain tungsten alloys for making high-speed tool steel, as the introduction of a small proportion of vanadium reduces the proportion of tungsten required to give the alloys the desired hardness and toughness. Vanadium differs from tungsten in having a beneficial effect not only on tool steel, but also on structural steel. It has been shown that vanadium does not form a double carbide with iron, but gradually takes the carbon from the carbide of iron until iron carbide can not exist, if 5 per cent of vanadium is present, and only a vanadium carbide containing 15 per cent of carbon, is present; this constituent is constant, at least in tool steels containing 5 to 14 per cent of vanadium. Chrome-vanadium steels and chrome-vanadium molybdenum steels are the latest development in structural alloy steels that have gained an extensive market. Almost all these steels are made in the open-hearth furnace, chromium and vanadium alloys being added shortly before casting. In their physical properties these steels are much like chrome-nickel steels, but they have a greater construction of area for a given limit. Most of the chromium-vanadium steels made go into automobiles. Some manufacturers prefer them because of their greater freedom from the surface imperfections, notably seams, which the steels that contain nickel are likely to have. Some chromium-vanadium steel, which is not face-hardened but has high resistance imparted by heat treatment, is used in armor plate of medium thickness.

Mining

Is the Coal Mining Industry Efficient?

—As a rule the miner does not confine his efforts exclusively to shoveling coal. While he should be an adept in the use of the shovel, necessity demands that between filling successive cars, he vary his labor. Thus he drills holes, charges them with explosive, picks down coal, sets props and gobs refuse. This variation in employment materially relieves his muscles and gives him a diversity of occupation to vary the monotony of shoveling. The miner and the management in most mines—and this applies to company or daymen as well as to those working on tonnage—cooperate less effectively than in most other industries. The miner fails to receive the necessary cars in which to load his coal. The men upon whose labor the miner depends fail to coordinate their work with his. Supplies are not furnished him as needed. No instructions are given him to assist him in performing his work, nor—and this is of even greater importance—is any analysis made of conditions and methods to find out how his work can be made as easy as possible. Left thus without support the miner is rendered irritable. Beyond question this lack of coordination is one of the major reasons why the miner is habitually dissatisfied with his life. A miner may readily lose from one-fifth to one-third of his daily earnings through failure of the management to supply a needed mine car. These are some of numerous reasons given for the high cost to the user in a report on "Underground Management in Bituminous Mines" made to the U. S. Coal Com.

Economic Utilization of the Lignites of the Northwest, which comprises nearly one-third of the total solid fuel resources of the United States, depends upon the devising of methods for the production of a maximum yield of solid salable fuel at low cost rather than on the obtaining of long

lists of by-products which unduly optimistic promoters have emphasized, states W. W. Odell, fuel engineer, Department of the Interior, in a report just made to the Bureau of Mines. Mr. Odell's conclusions are based on the present state of industrialization of the great lignite producing States, North and South Dakota and Montana, which would not provide a market for the gas and other by-products obtained in the treating of the lignite. It is believed that the lignite carbonizer recently designed by the Bureau of Mines fulfils the requirements of the situation, producing at low cost a fuel, in the form of lignite char, which has a heating value equal to the fine sizes of commercial anthracite and which can be briquetted and compete with domestic sizes. Lignite contains more than 30 per cent of moisture exclusive of the water of decomposition formed when it is carbonized or burned. The heating value is approximately half that of good quality bituminous coal. Various processes have been proposed for treating lignite, some of which, it is claimed, will permit the recovery of a large yield of valuable by-products. Some promoters have gone so far as to promise the recovery of perfumes, dyes, and medicinal products, and they bolster their claims by drawing attention to what is being done with tar of various sorts in distant lands. To date these processes exist on paper only. It is a well known fact that carbonaceous materials, such as wood, lignite, coal, or the like, will yield, upon carbonization, a small percentage of condensable products—chiefly water and tar. The nature of the tars so prepared and the percentage yield is dependent to a certain extent upon the method of carbonizing and upon the temperature employed. This affords a fertile field, for promoters with a vivid imagination to work in. The Dakotas, where much of the lignite of the Northwest is found, are, however, sparsely settled and relatively undeveloped industrially, hence a high value cannot be placed upon the by-products, gas, tar, and ammonia, or upon the tar distillation products since they are remote from market. There are no refineries in the Northwest for handling or "working up" special products from lignite tar. Furthermore, lignite tar is not the same as coal tar, and therefore the crude products from the distillation of the former are not necessarily identical with those from coal tar. Uses for lignite tar in large quantities at a price higher than its fuel value are yet to be found. In Europe some of the brown coals are of such a nature that they can be commercially briquetted without a binder after crushing and drying the raw fuel to a moisture content of approximately 12 per cent. The lignite found in the Northwest does not readily lend itself to treatment in this manner.

A New Coal Mining Method.—The coal strip-pit operator is taking a leaf from the ice harvesters' book. He is "sawing" up his coal into long panels, 12 feet wide so that a few pop shots will loosen it in big lumps for easy and economical loading. This reduces labor and powder costs and saves time. It increases the value of the coal because the fuel comes cleaner and with less slack. It also improves strip-pit practice in a variety of other ways. All this is directly creditable to the adaptability of a type of underground longwall coal cutter for open-cut mining. The machine, instead of lying in its normal horizontal position with its cutter bar extending outward, as for an undercut, is turned up on its edge with the cutter bar extending downward. Thus the machine performs the function of the ice harvester's cross-cut saw. This new coal cutter is a longwall machine, turned up on its side, and mounted on a steel shoe or skid. When moving from place to place, the cutter bar is locked in line with the body of the machine. The lines to be cut are laid off lengthwise of the pit, and a hole is bored every 50 feet ahead of the machine. In these holes pins are inserted, to which the feed chain is secured. The machine pulls itself along the chain on its skid, making a straight cut the full depth of the seam. Two men, a runner and a helper, handle the cutter. The helper's chief duty is to shovel the cuttings away from the channel. In a pit which is 50 feet wide, four channels each 150 feet long are cut by the machine 12 feet apart, and the machine handles the 600 feet of cutting readily in an eight-hour shift. It is thus able to keep well ahead of the loading shovel. Two holes are drilled in each 12-foot block of coal, three to four feet in

(Continued on page 422)

"Look, it glistens. Hold it, it's heavy. Tap it, it rings."



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Lead makes glass heavy

Lead also gives weight to glass. The piece of fine plain glass and cut-glass you pick up may be anywhere from 20% to 50% lead. Table glass, such as tumblers and goblets, is from 20% to 40% lead. When it is struck, lead glass in most forms gives forth a musical ring that ordinary glass does not.

Lead also gives the glass a softness that makes cutting and engraving easier and more economical. Despite this softness—because of it, in fact—lead glass retains its strength and offers greater resistance to changes of temperature than ordinary glass.

How lead gets into glass

To say that the glassmaker gets beauty by mixing lead and some other materials sounds almost magical. Yet from the same lead that is used for water pipes he gets two powders, red-lead and litharge, by melting the metallic lead in furnaces where the molten lead is exposed to currents of hot air. He takes either the red-lead, or the litharge, and mixes it with silica sand, potash, saltpetre and other chemicals. Then he melts these all together and obtains the liquid glass from which various kinds of glassware are molded or blown.

One glass manufacturer in a year used

200,000 pounds of lead. The entire glass industry takes about 14,000,000 pounds of the annual lead production in the United States.

Lead makes glass an object of beauty and admiration. Both at home and on the street, lead, in spectacle and reading-glass lenses, aids the vision of many thousands.



Under the lead-glass lens of the microscope the scientist segregates the germs that may cause sickness and perhaps death

The astronomer searches the Milky Way with the powerful lead-glass lens of his telescope. The chemist and the biologist invoke the aid of the microscopic lens in which is lead. The photographer and the motion picture operator with their camera lenses containing lead record the pictorial history of the world.

In the millions of buildings that are lighted by electricity, lead in electric light bulbs is helping to make night as much like day as possible. The glass used in other ways for illuminating purposes is also generally lead-glass.

Lead as paint

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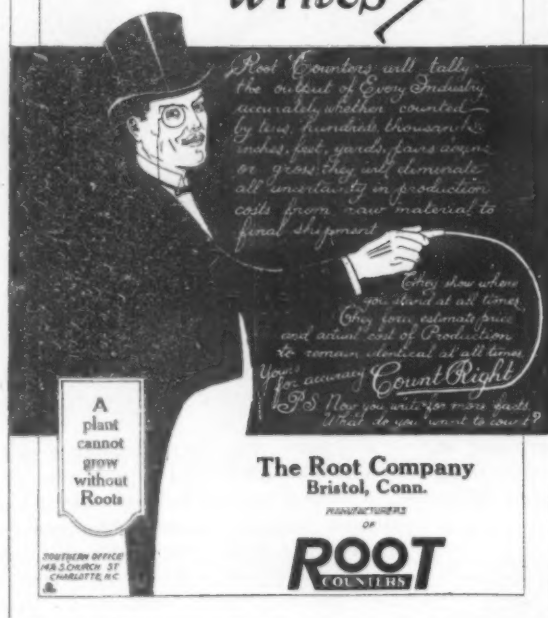
If you wish to read further about lead, we can tell you of a number of interesting books on the subject. The latest and probably most complete story of lead and its many uses is "Lead, the Precious Metal," published by the Century Co., New York. Price \$3. If you are unable to get it at your bookstore, write the publisher or order through us.



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Scientific American Digest

(Continued from page 420)

from the free end. These are shot with six ounces of black powder each, the two holes being wired together. The longitudinal cuts provide two additional free faces, so that the light powder charge is sufficient to crack off the coal, without materially shattering the lump. As a result the percentage of large coal has been increased from 12 to 15 per cent and the cost of powder per ton has been cut in half. One keg of powder now loosens 200 tons of coal, instead of 100 tons, which was all that could be obtained without channeling.—*Coal Age*, 25:12, 2 pp., ill.

Explosions of Coal Dust such as have caused a toll of hundreds of lives in American mines within the past few months can be greatly minimized by proper rock dusting methods, states the Department of the Interior, which recently commissioned George S. Rice, Chief Mining Engineer of the Bureau of Mines, to make a study of the use of these methods to prevent the propagation of coal dust explosions in European mines. The rock dust is spread upon the floor, roof and sides of passageways or placed upon specially constructed barriers, and when stirred up by the concussion of a local explosion, forms a screen which prevents the flame of the explosion from propagating beyond the immediate area of origin. Stone dusting as a means of limiting coal dust explosions is made compulsory, by governmental regulation, in Great Britain, except in anthracite mines and in bituminous mines that are naturally wet throughout. A great many British mines of large capacity have used rock dust for more than ten years. The majority of British mines for the past four years and practically all mines for the last two years have been using stone dust. No coal-dust explosions have occurred or have been propagated in any part of a mine that has been thoroughly stone dusted. Although the Bureau of Mines has urgently recommended rock dusting, only a few operators in the United States have adopted the practice. Operators of mines in southern Illinois that have installed rock dust barriers state that these have prevented many coal dust explosions from extending beyond the location of the barrier. Other operators of mines where disastrous coal dust explosions have occurred, in spite of precautions taken to keep coal dust thoroughly dampened, are now considering the adoption of rock dusting. The cost of rock dusting in American mines per ton of coal produced is believed to be much less than that of efficient watering. This small cost is a low price for protecting human lives and for insurance against disasters that involve heavy financial losses from the payment of death and injury benefits and through damage to property. Results of these investigations are contained in Bulletin 225, copies of which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Electrical Prospecting.—Discovery in Sweden of two new iron and copper sulfide ore fields, the deposits in which were totally masked or covered with glacial drift, has been accomplished since 1918 by prospecting with electrical apparatus devised by Hans Lundberg and Harry Nathorst. These are the Kristineberg and the Bjurfors fields, both in the Skelleftea district, about 450 miles north of Stockholm. The former was found late in 1918, and the latter in the summer of 1922. Since 1918 the method has been tried—successfully it is claimed—by a Swedish company at about sixty different districts in Sweden, Norway, Finland, and Spain. Efforts to improve the method have been made by the company, the Swedish Geological Survey, and others. Briefly it consists in observing the distribution of a direct electric current passed through the ground, each of the two contacts with the earth being made with several metallic pegs connected with each other and driven in the ground several meters apart, usually in a circle. Potential differences established in the area between the two circular contacts are determined by means of a movable length of wire having a non-polarizing electrode at either end and a galvanometer in between. Points of equal potential may thus be located, and when mapped, the resulting configuration of equi-potential lines indicates the presence of conducting masses beneath the surface. The work of Lundberg and Nathorst is promising, marking as it does material progress in the science of electrical prospecting. Another recent step has been the extensive experiments of Schlumberger and



Is Einstein Wrong?

FOR SEVERAL years after he watched the historic apple fall, Sir Isaac Newton had difficulty in producing evidence which would make acceptable his theory of universal gravitation.

Some of Albert Einstein's predictions, relating to astronomical phenomena, do not seem to have been completely borne out in observations made during a recent eclipse. Charles Lane Poor, Professor of Celestial Mechanics at Columbia, leads off the monthly debate in the June number of

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with an article entitled "The Errors of Einstein." The second article of the debate,—"The Triumphs of Relativity"—which will appear in the July number, is by Archibald Henderson, Professor of Mathematics in The University of North Carolina, who, fresh from a personal interview with the German scientist, begins by saying with emphasis, *There are no errors of Einstein.*

Both these articles are written in a readable manner, and together furnish a valuable and comprehensive study of a theory which many scientists believe will supplant the law of Newton.

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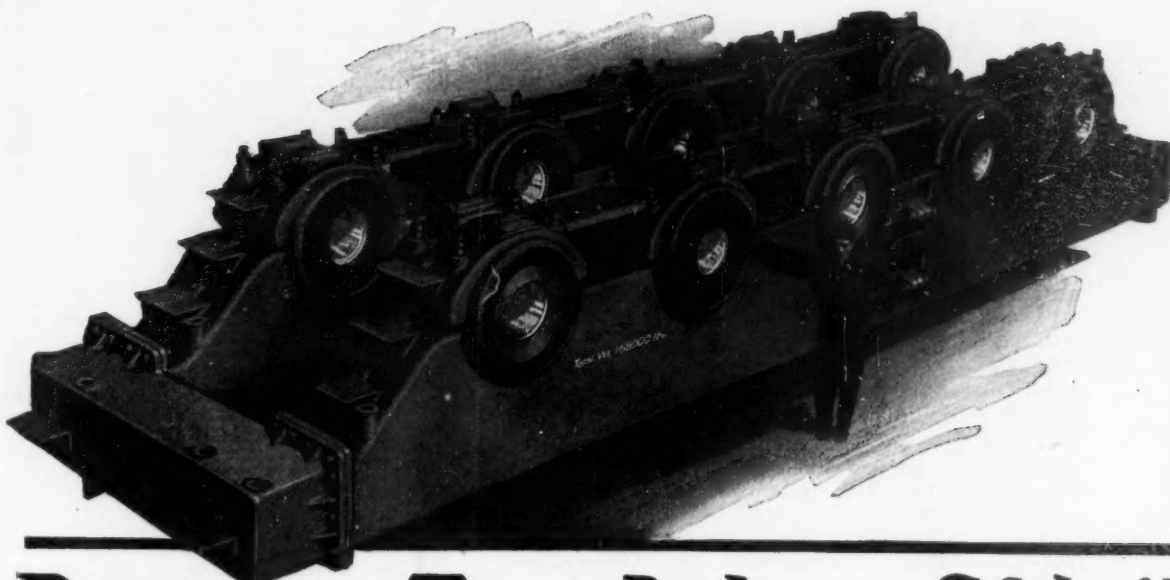
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Kelly with the "spontaneous polarization" method of the former, which involves the study of electric currents originating in the sulfide orebodies themselves. This method is simple and easily used where conditions are right, but will hardly prove as widely applicable as the other methods discussed which involve the artificial creation of an electrical field.—*Eng. and Min. Jour. Press.*

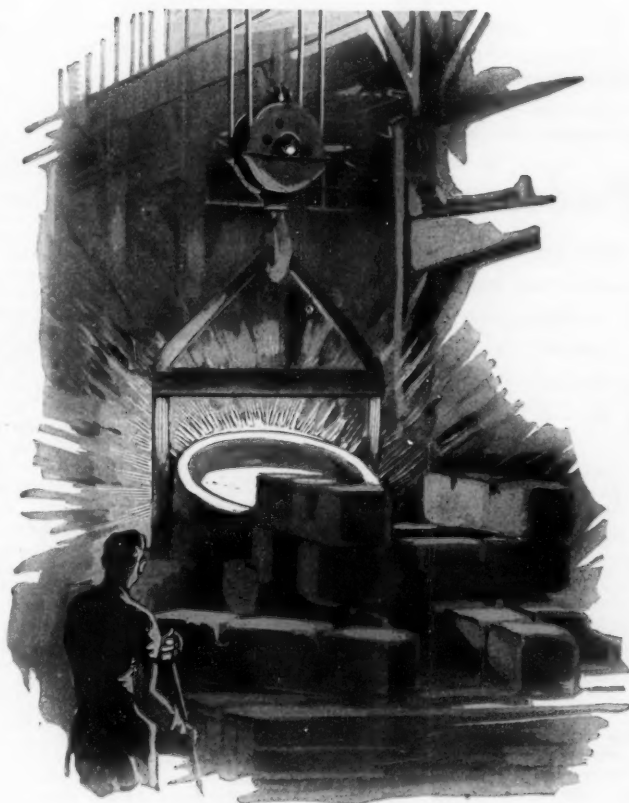
"Stone Dusting," the method employed in British coal mines to prevent the widespread of mine explosions, has proved more effective than the watering methods relied upon in most of the coal mines of the United States, according to an official mission from Great Britain which is now returning home after having spent several weeks in this country arranging for joint research work with the Bureau of Mines, under a plan officially agreed upon by the British and American Governments. The mission witnessed a series of coal dust explosion tests at the experimental mine of the Bureau of Mines at Bruceton, Pa. British Silkstone coal dust, similar to Pittsburgh coal dust, was used, and the tests indicated that the British coal dust required about the same amount of inert or rock dust as the Pittsburgh coal dust in order to prevent an explosion from starting; or, if an explosion of firedamp occurred, to prevent the explosion from propagating through the agency of coal dust, this being the cause of all widespread coal mine explosions. Meetings with mining men were held in Pennsylvania, West Virginia, and Illinois at which the members of the British mission explained the method of rock dusting as used in Great Britain, where it is known as "stone dusting," and where some collieries have used it for more than twelve years. Its use in Great Britain has been compelled by law in all naturally dry mines since 1920. Since that time, there have been no explosions in thoroughly dusted mines. Except for a few mines, rock dusting to prevent coal dust explosions has not been used in the United States, although it has been strongly recommended by the Bureau of Mines. Watering or humidifying has been relied upon in the coal mines of this country, but the numerous coal dust explosion disasters of the past two years, some of which have occurred in what were considered well-watered mines, have caused mining men to be suspicious of the efficiency of watering. Bureau of Mines officials state that watering as a general method is a failure and they urgently recommend rock dusting. The method has several great advantages: It does not have to be applied daily in every part of the mine as watering has to be; the dust is visible and the presence of coal dust can be observed readily, which is not true in a watered mine; and the lightness of color of rock dust suitable for the purpose improves the illumination of the mine passages and so tends to prevent many individual accidents from haulage and dangerous roof conditions. Many kinds of rock dust are suitable for the purpose, notably limestone and light-colored clayey shale free from flinty particles which would be unhealthy to breathe. The Bureau of Mines offers to assist mine operators in determining the suitability of material which may be available for the purpose of rock dusting.

Mechanical Engineering

Spectral Analysis for Detecting Flaws.—Increasing numbers of industries engaged in the manufacture of metal products are finding a valuable aid in the method of spectral analysis of metals which they use, and which has been developed to its present state by the spectroscopy section of the Bureau of Standards. According to W. F. Meggers, head of this section, this system offers a more convenient and rapid means of detecting impurities in metals than chemical methods. Two big New England firms, one engaged in brass and bronze manufactures and the other in silver, are making constant use of a spectrograph, a device which makes this detection of various chemical elements a simple procedure. Other firms in Cincinnati, Ohio, and Buffalo, N. Y., are using the same development. It was while the Bureau of Standards was engaged in researches in this science that a problem came up. A steamship had been lost by a boiler explosion. In such boilers there had been placed a safety plug which was supposed to melt at a certain temperature forming one of the conditions preceding such an explosive point. The "safety plug" had apparently failed. "Why?" the Bureau was asked. The spectrograph revealed that



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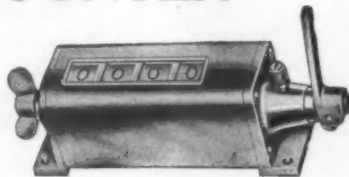
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plugs which were supposed to be of pure tin contained a trace of lead, zinc, and other metals in some cases. Pure tin melts at a temperature of 232 deg. C. The presence of lead or zinc or other impurities caused the formation of a compound which required a very high temperature for melting. The reason was clear. Hence the spectrum analysis had been applied in a rapid and convenient manner, and an optical method could supplant a more complicated chemical test. Other experiments have proved this belief.—American Machinist.

A New Development that has aroused the greatest interest among engineers and shipowners in Europe—is the new Föttinger system which has just been brought to a practical stage by the Vulcan Works at Hamburg. It is claimed, perhaps rightly, that when a Diesel engine drives a propeller shaft through gearing in the ordinary way, this gearing is subjected to shocks which it is impossible entirely to eliminate, even if a flexible coupling is provided. The arrangement employed by the Vulcan Works is to interpose hydraulic coupling between the engine shaft and the gearwheel. The whole of the speed reduction is effected by the gearing and not by the hydraulic coupling which merely serves to give complete elasticity to the drive and thus to prevent any trouble arising in the gearing itself. Several other advantages are claimed. When maneuvering, no compressed air is needed for starting the engine, since it can run light by merely discharging the fluid from the couplings. The saving in weight is considerable as compared with the normal drive. The total machinery weight of a 9500-ton cargo ship equipped with two 2000 brake horsepower engines running at 285 revolutions per minute and driving the propeller shaft at 105 revolutions per minute is 717 tons, against 1138 tons with direct-coupled engines. For each Diesel engine there is an ahead and an astern coupling, the former being aft and the latter close to the engine. Between them is the pinion driving on the gearwheel on the propeller shaft. The Diesel engine shaft passes through the pinion wheel and is attached to one impeller in the ahead and one in the astern coupling. A second impeller in each coupling is keyed on to the shaft of the pinion wheel itself. When the engine has a drive in the ahead direction, the working fluid, which is lubricating oil, is removed from the astern coupling, but the ahead coupling is full. The reaction of the impeller on the Diesel engine shaft, causes the impeller on the pinion shaft to rotate and thus drives the propeller shaft at practically the same speed, the slip being perhaps 3 or 4 per cent. It is not essential that lubricating oil should be employed as the working medium. In large installations it is proposed to have water for this purpose. The efficiency is higher than might be anticipated and amounts to 95 to 96 per cent, according to the tests that have been carried out. For this reason it is claimed that the new system is superior to the electric drive where the overall loss is generally in the neighborhood of 12 to 15 per cent.—Marine Engineer, 29:3, 2 pp., ill.

Machine Shop Chips.—Although the production of chips is one of the chief concerns of the management of a machine shop, their disposal is ordinarily given but little attention. A visitor to a machining plant sees plenty of chips being made, but he usually is not shown what becomes of them. Naturally, since the chips are a by-product, and a rather undesirable one at that, the management is interested merely in getting them out of the way as quickly as possible. Large and progressive firms have in many cases built up systems and plants for handling their chips on what might be termed a production basis, just as they do the work that they manufacture. At the plant of a machine tool company in Cincinnati, there is a chip handling plant that is quite up to date, and unique in some of its features. The functions of the plant are to remove the oil from the chips, to provide a storage space for each class of scrap and to facilitate shipment of the material. The structure is made of reinforced concrete and there are seven hoppers, each of which contains a different kind of material or grade of chip. The extracted oil is piped to the different oil filters and tanks. This cutting oil can then be used over again, and new oil is added to make up for losses. In addition, an antiseptic is put into the oil for the prevention of skin diseases that the operators of machine tools sometimes contract from cutting oils. The chip house will hold

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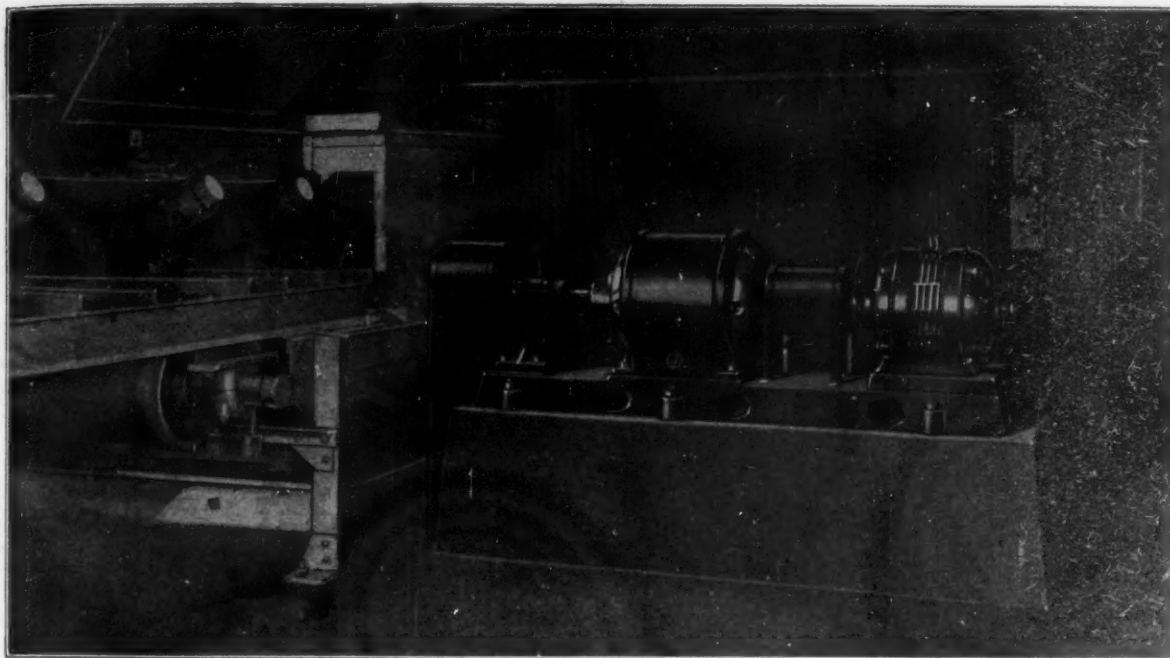
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a little over a carload of each kind of metal cut, and as soon as a carload of any kind has been accumulated it is shipped out. With the plant running at full capacity a carload might be accumulated in a month. A railway car is spotted beneath the hoppers on the track and the chips are dumped into it. What becomes of them after they are placed in the railroad cars is largely a matter of conjecture, as they are sold either to dealers in scrap material or directly to foundries and steel mills which have need for them and means of consuming them after they have been compressed.—*American Machinist*, 60:10, 3 pp., ill.

Industrial Progress

Mariemont, an interesting example of modern town planning and development, is now under construction just outside Cincinnati, Ohio. The completion of this town will achieve the goal of years of careful thought and planning on the part of Mrs. Mary M. Emery of Cincinnati and Charles J. Livingood, manager of Mrs. Emery's extensive properties. Mrs. Emery is to spend millions for the establishment of this modern community to promote the happiness and contentment of citizens of moderate circumstances and to provide, within their means, the conveniences and necessities of life consistent with present-day American standards of living; only a minimum property rental will be charged, which will be just sufficient to pay a moderate return upon the capital invested. The development, comprising some 365 acres, will be provided with complete underground utility systems of the most modern and approved types. There will be about 11 miles of improved streets, paved in accordance with the best practice. Homes for a population of more than 7000 people will be provided by constructing houses of various kinds, such as apartments, group houses, and semi-detached and detached houses. There will be ample opportunity for amusement and recreation, education and worship through the establishment of parks, playgrounds and athletic fields, schools and churches. A feature of the town will be its attractive Town Center and Village Green, situated at the convergence of several important thoroughfares. About the Town Center there will be numerous public buildings and business establishments, including a town hall, library, community club house, hotel, theater, post office, bank, stores and business offices, and a public market place. Industrial sites with excellent railroad facilities will be available. The industrial area, when completely developed, will provide employment for 3,000 to 4,000 workers.—*American City*, 30:3, 5 pp., ill.

A New Method of Cleaning Castings, successfully experimented with at the Erie, Pa., foundry of the General Electric Co., was described by Carl B. Lockhart of that plant in a talk before the members of the Pittsburgh Foundrymen's Association. He reported not only a considerable saving in labor, but also of time, since the method briefly is that employed in hydraulic mining, and a casting which would require a day's time of two men to clean by hand, has been done, the speaker stated, in 30 to 45 minutes. Dust, that makes cleaning room work so unattractive to the workmen, is eliminated and apparently the possibilities of the method have only been scratched. A centrifugal pump boosts the water pressure from 100 pounds to 250 pounds and delivers about 256 gallons per minute. It was necessary to dig a sump and to connect it to the sewer system, to dispose of the excess water. A Monitor turret type nozzle, with three-quarter inch tip, similar to those used on the decks of fire tugs, was adopted, mounted on a three inch standpipe, the piping from the pump to the nozzle being three inches. The operator stands just outside the room and heavy plate glass windows in the walls just above the nozzles permit him to look into the room to watch the progress of the work. A small one-half inch pipe with holes drilled in it is installed just above these windows, so that the operator can wash them off from time to time as they become covered with dirt during the washing operation. All of the waste material is washed down the sewer, which never becomes clogged, and the cost of handling is thus eliminated. The sand, gravel and coke which remain behind are used over again. This washing process has eliminated all of the dust usually seen in a cleaning room where large castings are cleaned and makes it a desirable place in which to work.—*Iron Age*, 113:13, 2 pp., ill.



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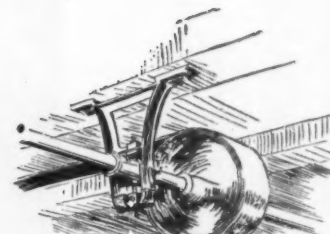
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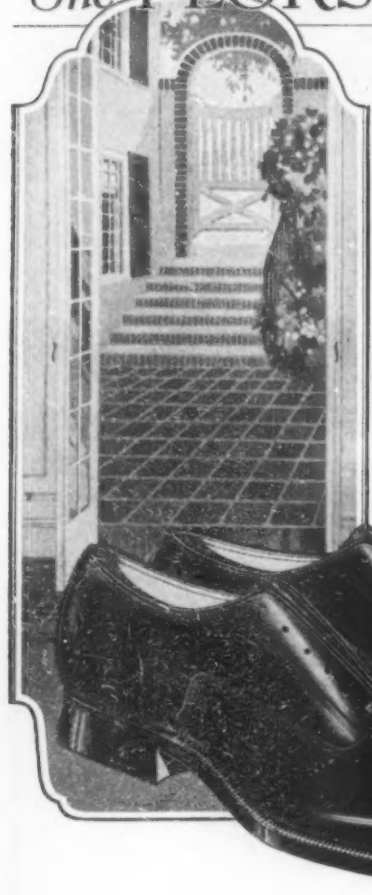
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The Criminal as an Inventor (Continued from page 377)

over the entire sheet. An astounding sight greeted the gaze of the officials, for wherever the man had written in spittle with his pen, the words and letters stood out clearly in black and could be read as easily as any other writing.

This method is not on the official roster of secret communication methods and it was unknown to our letter inspectors in the late war until a friend of this writer bore the secret to headquarters.

Mention of this affair brings to remembrance the fact that convicts have been master inventors of secret methods of communication and of smuggling, some of their practices and codes being of the most ingenious, complicated and surprising kind. But this matter has been treated at length by others and I have not space to go into details here. The art of hidden communication reached its height, to be sure, in the days when talking was forbidden among prisoners.

Another type of invention to which the criminal has devoted unremitting attention for centuries is the secret door or magical cabinet. The reader must remember that no castle of old-fashioned romance was without the former and that the latter has been widely employed by conjurers and spiritists. Since such products can hardly have had any licit use to begin with, their attribution to criminal origins is almost automatic. A single anecdote will serve to illustrate the uses to which magical cabinets were put.

In the fall of 1879 a most distinguished looking gentleman, somewhat far advanced down the slide of life, to judge by his snowy hair and silvery beard, arrived at the Hotel Geneve in Naples. With him came a battery of large trunks and, what was more to the esthetic eye, a most prepossessing damsel—tall and stately and ripe to opulence. The gentleman announced that he was English and permitted himself to be called milord, though some thought there was a Teuton burr in his consonants. The lady was his niece and occupied a room adjoining that of milord, which fact is important to the unfolding drama.

The newly arrived couple had no sooner got their trunks opened than two large cabinets appeared in the shape of moderately high desks with drawers below and a tablet above that was pulled down for writing, disclosing other smaller compartments and drawers. Whoever has meandered through the neo-antique shops must be familiar with these contraptions. As soon as these affairs were unpacked, milord pushed one of them through into his niece's room, pulled out a small drawer that was fitted with lock and key, passed his arm back until it must have struck the back and then carefully moved the cabinet over, with its back against the door connecting the two rooms, which had meantime been closed. Going to his own room by way of the hall, he placed his cabinet in a similar position against the door, pulled out a drawer corresponding to that he had drawn in the opposite room and made some marking on the door with a pencil. This done, he drew his cabinet away again, cut a piece out of the thin panel of the door with an auger and a jigsaw, and put his cabinet back into place.

A few days later, after the newcomers had satisfied the host of their superior breeding, a thing not difficult to do, if one have the ready bank notes, the milord Inglese stopped in to visit Amalfi, the principal jeweler of the place. He went over the jeweler's stock with fat superciliousness and wound up by buying a scarf pin for a thousand francs. He paid in cash and asked that the trifle be sent to him at the Hotel Geneve.

A week later he appeared again with a most beautiful jeweled and enameled watch. Could Signor Amalfi supply the missing stones and repair the injured enamel? Indeed he could, as well as any man on this rich round ball. So the watch was left and soon thereafter called for.

On the occasion of this third visit, milord looked over a good many precious trifles, bought a bauble or two and remarked casually that his niece had become engaged and that he must go to Paris and buy a string of diamonds, which was to be her gift from him. Could Signor Amalfi recommend the best jeweler. And Amalfi, quite up to human expectations duly and fluently recommended himself. So saying he brought forth from his safe a collar and necklace which had just been bought from the unfortunate Princess di Pasto for a ridiculously small sum. The thing was readily worth 600,000 francs. But, under the circumstances, 450,000 would fetch this marvelous creation.

Milord examined it critically and went away, saying that he would consider. He really had fancied something more expensive for his beautiful niece.

Poor Amalfi sat in the brine for several days before milord deigned to put in an appearance again. This time he had made up his mind to take the thing. After all, it was money enough to spend on a woman's throat. But he would have to arrange to bring the money from his bank in Rome. That would take four days. So then! Let Amalfi bring the trinket to the Geneve at 11 o'clock on Saturday and all would be well. But the whole business must be a secret from the niece. She must under no circumstances see the necklace or suspect the jeweler's mission.

On Saturday Amalfi appeared and was ushered up to the room of the milord with vast ceremony. He found his distinguished client waiting for him. They sat down at once and the diamonds were passed over to milord for a last inspection. He had them in his hands, passing a critical eye upon them, when there came a light tapping on the door and a musical young woman's voice calling "Uncle! Uncle!"

Milord spun about in a twinkling, tossed the diamonds and their case into a drawer of the cabinet, beside which he had been sitting, took a key from his pocket, ostentatiously displayed it to Amalfi and locked the drawer.

He was none too swift, for the resplendent niece opened the door without further ceremony and came into the room announcing that milord's tailor had been waiting some time in the other room and was fuming.

With a wink at the jeweler, who bent a favoring eye upon this young charmer, milord remarked that his niece would entertain Signor Amalfi while he went to appease the tailor.

The jeweler and the beauty sat and chatted. They chatted of this and that. They waited. They grew a little restless. The lady relieved the situation with slight coquettishness which rallied the flagging patience of the jeweler. Again they chatted and once more waited. At last the girl grew impatient, said that the tailor was an old bore and went to summon her uncle.

Signor Amalfi waited alone now. He waited an hour. Then he summoned the hotel proprietor, who assured him that he had seen milord go out with a gentleman, and milady soon afterwards, evidently in quest of her uncle. Amalfi mentioned the necklace and indicated that he had seen the thing locked into the drawer of the cabinet.

The landlord threw up his hands in horror. What an absurd fear of Amalfi's! Why these people were finer than spun gold. It was the way of great folks like these to be forgetful. No doubt, milord had gone off on some tangent and his niece was seeking him. Let Amalfi contain himself. Besides, weren't the diamonds locked in the drawer.

Content once more, the jeweler relaxed on a couch and waited, the hours passed; then the day. At nightfall he would be put off no longer. Let the Englishman like it or not, he would not go home without his diamonds and he must go home. He'd break into the cabinet and if milord wished to sue, let him try it.

A poker was procured and the drawer broken open. There lay the jewel case, leering open with its satin throat. But the diamonds?

Milord had merely stepped around into his niece's room, pulled out the trick drawer there, reached in, taken the diamonds and gone upon his way. And the beautiful niece, having allowed her dear uncle to catch the boat, hurried after him and took a train going in the opposite direction. All her effects and his, excepting some empty trunks, had been previously removed and there was nothing by which to trace these cabinet thieves.

Taking the Stenches Out of Industry

(Continued from page 379)

that a cubic foot of the carbon will take up, the distillation temperatures necessary to recover it from the carbon, and like factors. But the largest installation for this purpose handles only about 4,000,000 cubic feet daily, where a garbage reduction plant for a big city would require the handling of twenty-five or even a hundred times the volume of gas.

The largest gasoline-recovery plant uses from nine to twelve tons of the carbon in three different absorbers, only two of them working at a time, while a third is being distilled, so really only six or eight tons are actually in use. At that rate, a big garbage

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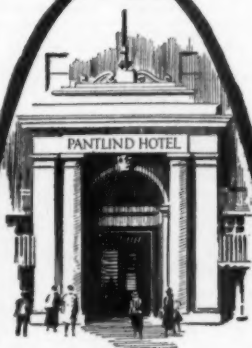
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reduction works would need towers containing a good many tons of the coconut charcoal, a considerable investment. However, Dr. Chaney says that when the chemist knows the "stench load" factor of this particular nuisance, probably he can so arrange his carbon sponge that smaller quantities of carbon will handle larger volumes of gas, being arranged so there is more exposure surface.

The cost of the carbon sponge is not so serious as certain other factors. Once bought, it can be used over and over, but if power must be used to force several hundred million feet of garbage gas daily through an absorbing system, at high pressure, even if it can be done as cheaply as two cents per thousand cubic feet per day, the power charges would come to several thousand dollars a day, which is too expensive. Therefore the engineering design must be worked out with a view to keeping the power requirements at a minimum.

The bare suggestion that offensive odors can be eliminated has aroused great interest among manufacturers in the stigmatized industries, indicating a willingness to make their plants inoffensive as soon as science shows how. But at present the chemist, surrounded by eager questioners who want to know what can be done in this case or that, asks for more time to get facts like those of the stench load, the power cost of handling gases, the kind and quantity and absorbing capacity of carbon for different purposes, and other problems that require further research.

Instead of burning or rendering garbage, an Italian scientist, Dr. Giuseppe Beccari, simply calls microbes to the colors and lets them make an odorless humus for the gardens out of kitchen leavings, stable manure, lawn clippings, fallen leaves, animal carcasses and other wastes found in the garbage can. Fermentation does the work inoffensively. The fats and tannage are lost, to be sure, but something useful is left nevertheless, where incineration destroys everything.

It is an improvement on the farmer's manure pit and the compost heap in your backyard where you pile grass clippings and leaves to rot. Dr. Beccari first worked it out for Italian farmers, and the principle was adopted by municipal authorities in that country eight or ten years ago. Coal is too expensive in Italy for either incineration or reduction, and dumping garbage in such a crowded country involves expensive hauling. So the Beccari system, successful there, is now being demonstrated in France, England and this country.

By this system, the garbage carts back up to a Beccari "zymo-thermic cell" and dump their contents until it is filled. This cell is Beccari's invention. It may be any size from one cubic yard up, but for city use there is a standard cell about ten feet high and eight by nine feet in width and length, built of tight masonry or concrete, tightly covered to prevent the escape of odors.

The thing is practically a stove in which garbage burns by fermentation or bacterial action instead of fire. For there is a grate at the bottom upon which the garbage rests and air ducts for the creation of a draft, and a short tower corresponding to a chimney. The cells are built in series, and after one has been filled and closed the temperature of the garbage rises to between 140 and 160 degrees Fahrenheit, remaining heated for about twenty days, according to the season and weather, and then slowly cooling down. In from 35 to 45 days it is opened. Nothing is left but a moist residue resembling loam which, when dried, can be used to enrich garden and farm soils like compost. The carcass of an animal put into one of these cells is reduced to the skeleton, free from flesh and cartilage. Everything in garbage except bones, crockery, glass, metal and the like is reduced to this residue, which is odorless, and better than compost or manure from pits as a soil enricher because it contains some nitrogen, phosphate and potash. The gases generated during the process pass through the tower, where there are "baffles" or shelves with layers of absorbing earth and sulfate of iron that catch and fix their volatile nitrogen and ammonia for fertilizer. This escaping gas is made quite odorless. Garbage in these cells has, for test purposes, been inoculated with disease germs as virulent as the anthrax spores, but at the end of twenty days the germs had been utterly destroyed.

Then, there are great things a-doing in the meat packing industry, long infamous in this matter of industrial perfumes, and damned by and large for them.

The other day, a chemical engineer con-

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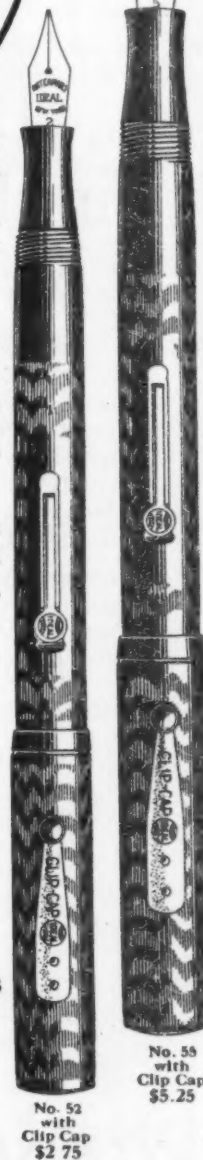
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Big little items in the family budget

ABOUT 70 per cent of the parts of an automobile consists of small bits of hardware, such as washers, nuts, bolts, screws and pins.

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By standardizing these minor parts for its divisions, General Motors effects large economies which contribute to the quality and value of its cars, and increases the sources of service to their owners.

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needed with that industry made a prophecy that promises a revolution.

He said that within two years every successful meat packing plant of any size would adopt a new process eliminating obnoxious odors, and that the soap-rendering works and garbage-disposal plant would soon fall into line behind the packers.

It may take more than two years, but otherwise the prophecy seems conservative, for today this process is foremost in the thoughts of packing house people all over the country. It is well worth thought, because it promises to cut down to less than one-half their present overhead expenses, and give them more high-grade products to sell.

There is really only one department of a packing establishment that generates offensive odors—the tank house. Other departments are preparing food under Government inspection, and have the appetizing fragrance of the butcher shop and kitchen. The tank house handles what can't be used for food, turning it into soap grease and fertilizer, and just to be certain that the soap grease will be made into soap, it is generally denatured and made uneatable beforehand.

"There are four ways," a plant engineer once said, "in which products leave a packing house. They go by team, by railroad, down the sewer—or out through the tank house!"

Butchers admit that this part of the plant has been most neglected, though its odors have been reduced by quick handling of material and constant cleaning in recent years. Nevertheless, millions of pounds of good food have, through neglect, gone to the tank house, and the nature of the materials handled, together with the method of rendering them with steam, has made bad smells inevitable.

Now this new process called "dry rendering" has been developed by Myrick D. Harding, superintendent of a big Chicago meat packing establishment, and it has led John P. Harris, a chemical engineer, to make the above prophecy.

The idea is something like this:

Around the ribs of meat animals there is fine fat and tallow, easily rendered for food by cooking in its own "juice" in steam jacketed kettles, as mother used to "try out" leaf lard. But that is only 15 per cent of the fat in the animal. There is a lot more in the trimmings, bones and various parts that do not go into the butcher's meat. These have been sent to the tank house and put through a "wet rendering" process, being cooked with a considerable volume of water in a closed pressure tank. Such fats are high in acid, strong in flavor and odor, and unfit for food. The tank water in which they are cooked is heavy with meat solids, which are extracted and dried, making tankage. The odor of tankage is so bad that it is used chiefly for fertilizer, though it could be used for stock and poultry food if of a better grade, bringing more money to the packer and the farmer.

For years, packing house men have sought some way to get rid of the tank water, which is blamed for all the stench and waste of the tank house. This new dry rendering process handles tank house materials without water. It extracts the fat by roasting instead of boiling, and changes the odor of the tank house from a fertilizer smell to one of cooking. The trimmings, bones and other material are first chopped fine in a hashing machine, and then cooked in a revolving kiln that keeps them in constant agitation. When sufficiently cooked, they go to a percolating machine, the invention of Mr. Harding, that separates the fat from the "cracklings." Hitherto it has been impossible to get a satisfactory percentage of fat out of the cracklings by any dry cooking process, but this percolator does the work, experts say. Besides yielding more industrial grease, and a better quality without offensive odors, it leaves cracklings instead of tankage, to be ground up into stock and poultry food—a coarse grade of "Philadelphia scrapple" for the cows and chickens, as it were.

Everything that goes into the melter is fresh and sweet, and comes out fresh and sweet. Tank house fats rendered by this process, though used only for industrial purposes, are in many cases of food quality. And more food fats can be saved from the tank house by dry rendering. Besides making better products, and effecting marked economies in labor and fuel, this process makes the tank house a pleasant place to work, where heretofore it has been avoided by everybody in a packing establishment except the folks who had to work there, and they have not always been the best kind of workers because nobody wanted that sort of job if he could hold down a pleasanter one. Another odor that seems scheduled for

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elimination is the "fishy" smell of the fish market, wharf and fishing vessel. This has been a handicap for years in the fish dealer's business, turning away customers. Popularly, it is a humorous subject, but people in the fish business do not see the joke. For landlords refuse to rent property to fish dealers, municipalities banish fish houses to lonely places, and the restrictions and laws imposed upon the industry for its smells have been a serious handicap in its development. The fish business in this country is an undernourished infant industry, for our per capita consumption of that food is pitifully small. And the smell of fish, more than any other single factor, is held responsible.

Science finds the odor of fish highly interesting.

You know, of course, that when you catch fish yourself, clean them immediately and put them right on the fire, they are not fishy either in smell or flavor. You have said: "That is because they're fresh," and let it go at that. But science says you may have just as good fish, devoid of the fishy odor, and quite fresh in flavor, days after they have been caught—yes, and weeks if they come out of cold storage—provided you understand what causes the fish odor and get rid of it.

Fish have a natural slime that makes them slippery. This is a coating that protects them against bacteria, as the skin of an apple protects its flesh from decay molds. Small fish caught and thrown back into the water are frequently attacked by diseases because their protective coating has been broken in handling. While this slime protects the living fish, it is itself inhabited by between 75 and 100 different families of oceanic bacteria, about one-third of which are comparable with those that cause decay on land in meats and other foods. Fish taken from the water will be sterile for 10 or 12 hours. Then the slime, growing warm, and an excellent culture medium, stimulates bacterial growth which penetrates the skin and flesh. And there's your fishy smell, which isn't characteristic of fish at all, but due to bad handling. It can be eliminated by butchering, cleaning and cooling fish as soon as they are caught.

This dovetails right in with an interesting new sales method that has lately sprung up in the fish business. Instead of selling fish whole, their meat is cut off in boneless filets, wrapped in water-proof parchment paper, and sold ready for cooking. These filets are so devoid of odor that they can be kept in a grocer's ice box with butter, and the butcher and grocer are able to sell fish, giving wider distribution. If a housewife wants boiled fish she can cook it right in the parchment paper, and nobody will know she is going to have fish for dinner.

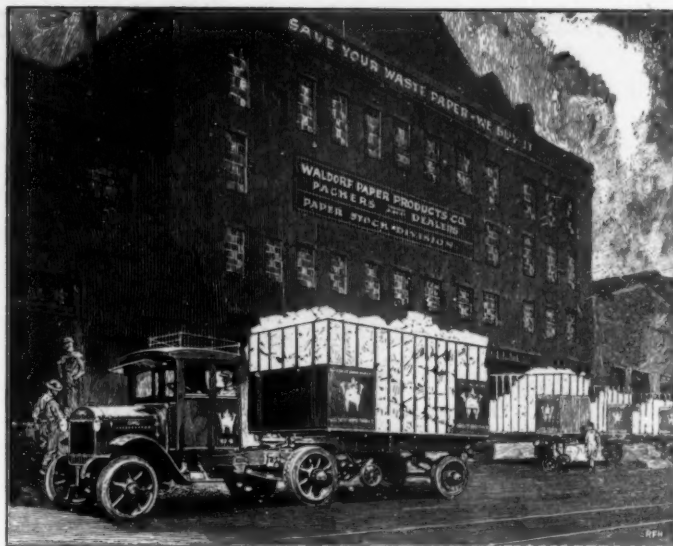
There is another way to get rid of the fishy smell in markets, on wharves, and particularly in fishing vessels. The odor of a well-seasoned fishing vessel tumbling around out at sea doesn't bother people on shore, but it is something that fishermen have had to put up with for hundreds of years.

"When it is going full blast," says Captain Frederick William Wallace, the sea novelist, "it will blacken white paint, make a lamp flame turn blue and discolor rubber boots. I could write a monograph on bilge perfumes. I've sniffed *eau de bilge* on the halibut and trawlers of the North Pacific, the shakers, haddockers and steam trawlers of the North Atlantic, the red-snapper snappers of the Gulf, and a few others. In some craft it is strong enough to make a skunk die of vexation at being unable to surpass it, or make a shark cough, or turn the stomach of an ostrich."

To get rid of this odor, fishermen rip up decks, take ballast out and scrub it with lime, lime-wash the hold and have a sweet ship for one out-going voyage, but as soon as fish are caught again, the bilge begins to get foul.

Besides writing novels, Captain Wallace edits a fishermen's trade journal, and not long ago set out to see what Science could do to deodorize the fish industry. He sent out a chemical engineer, M. M. Stone, with one of his sub-editors, to make a study of bilge water in the fishing vessels that come into Boston harbor. Samples of bilge water were taken, allowed to age several days, examined, and found to contain organic matter in suspension that gave off sulfuretted hydrogen—which is the odor of a bad egg. What Captain Wallace said about white paint was confirmed chemically, for white paint contains white lead, and that is soon blackened by sulfuretted hydrogen. The chemist then made experiments with differ-

(Continued on page 433)



Six GMC Tractor Trucks haul 16 semi-trailers for the Waldorf Paper Products Company, Minneapolis, Minn.

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Ask the nearest GMC dealer for definite facts and figures on the economy of tractor trucks in hauling volume tonnage, or write for special booklet.

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Radio Notes

Lightning and the Antenna.—Another fall, winter and good part of the spring have rolled by and we are back to summer days and electric storms, which are the curse of radio. At the first signs of warm weather many radio enthusiasts proceed to take down their antennae, for fear of the lightning hazard. Yet according to Dr. J. H. Dellinger, chief of the radio laboratory of the Bureau of Standards the lightning hazard is practically nil. Only for outside antennae need lightning protection be considered at all, he says. "It is very simple. A small and cheap device called a lightning arrester should be connected between the antenna and the ground wire on receiving sets. An antenna is no more likely to bring lightning into a house or apartment than are overhead telephone or electric light wires. The principal hazard from antennae is from stringing outdoor antennae over or near electric light wires. A number of persons have met death by electrocution from this cause."

Convenient Power for the Radio Receiver is now available in the recently introduced "Unipower" unit of a well-known storage battery manufacturer. This unit combines a special form of chemical recharger with the usual storage batteries for the filament and the plate circuits of the receiving set. The unit is permanently connected with the electric light socket, so that it is self-charging and will "float-in" on the line, and the radio listener may use the lighting current direct, so to speak, properly rectified and reduced to the required voltages. The Unipower unit is kept at full potential by fresh current coming in as fast as the set uses it up. Thus an owner may operate twenty-four hours a day, if he wishes. No battery cracking, buzzing or fading out such as occur when batteries are just too good to throw away, is experienced. The receiving set is always maintained at its utmost efficiency, so far as the battery current is concerned. The new unit will last for years, according to the manufacturer. It comes in a heavy oak case with connections grouped in a compact plate at one side.

Spark Interference comes up for discussion in the April issue of *Radio Broadcast*. We are told that the troublesome spark signals should not be so disturbing to us because a 500 kilocycle signal (600 meters wave length) is far enough away from most broadcast frequencies so that but little interference should be experienced except by those who are very near the spark station. But most of the trouble does not come from this spark signal frequency. For some reason better known to others than to us, many spark sets near New York Harbor are operated on a frequency of 606 kilocycle (450 meters), right in the middle of the broadcast band. At a recent meeting of radio experts in New York representing the U. S. Department of Commerce, the Canadian Government, and the commercial radio companies, it was agreed that spark transmission should be done away with as soon as practicable (perhaps within a year) and that the 606-kilocycle frequency should not be used at all by ships in American waters. This is a most admirable achievement and we are sure the radio public is much indebted to those responsible for the inauguration of this change in ship radio traffic.

The Sodian Tube, cleverly called "The Golden Rule Tube" because it cannot be made to oscillate and thus interfere with the radio reception of others, is coming more and more into use. It is quite different from the usual vacuum tube, although it is also a three-element tube. The sodion does not have a grid or control electrode interposed between the filament and the plate. Its name is derived from the fact that it utilizes some unusual properties of an alkali, such as sodium, and operates through the flow and control of ions. The input circuit of the sodion is connected between an electrode called the "collector," which corresponds to the grid of the ordinary tube, and which is bent into a U-shaped plate that partially surrounds the filament with its open side toward the anode or plate. The output circuit contains the usual head telephones or transformer primary and "B" batteries, and runs from this plate or anode to the filament. The output of the sodion is a varying plate current. In addition to the collector and anode members, the sodion tube contains a non-inductive heater coil which is in series with the filament and is entirely enclosed between the tube and an outer glass envelope.

Is the Antenna Doomed?—Many of the latest radio sets now reaching the public



Burgess "A" Battery Introduces a New Silent Partner

Notice that he's exactly my size—same height—same width—same weight. We look like twins. He is VERTICAL "B" JUNIOR. He has the same 22½ volts of pep as the rest of the Burgess "B" family. He is quiet—never talks to himself and he never lays down on the job.

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are of the loop type. What with the simplification of the Armstrong super-heterodyne circuit, as well as the development of radio-frequency circuits and reflex circuits, it becomes possible to produce compact sets which operate on small loops. No factor has had a greater influence on this move than the dry-battery tube, which makes possible the use of four, five or six tubes with a few dry cells for the filament current. Not long ago the writer of these lines attended the demonstration of one of the Armstrong super-heterodyne receivers. This particular receiver has a small, oblong loop inside the long cabinet, the latter being provided with a handle so that it can be carried about. Although the demonstration was held in the steel-encased Woolworth Building, loud and clear radio concerts were intercepted from the local stations and even from a station in Philadelphia. It is positively uncanny, this business of carrying a radio set about a room, while a concert comes out of the loud-speaker. Because of the directional characteristic of the loop, these loop sets provide additional selectivity, which is very desirable in these days of heavy radio traffic.

The Life of the B Battery depends on the following important factors, according to G. C. Furness, an authority on the subject: 1.—The quality of the cells in the battery. Each B battery consists of an assembly of a number of identical cells, each cell giving 1½ volts. Fifteen cells are used in a 22½-volt battery, 30 in a 45-volt battery. Before a good B battery can be made a good dry cell must be made, and that is no easy task. 2.—The size of the cells used in the battery. The larger the cells the more electrical energy they contain, and the longer they last. Size should be proportionate to use. 3.—The amount of current taken from the B battery by the tube or tubes. Obviously, the greater the current the shorter the life of the battery. 4.—The amount of daily use of the receiving set. Again, obviously, the greater the number of hours the set is in use each day, the fewer days will the battery last. 5.—The "cut-off" voltage. As any battery is used its voltage gradually drops until a point is reached at which operation is unsatisfactory. That is the "cut-off" voltage, the lowest voltage at which the set gives satisfactory results. The lower this voltage the longer the life of the battery. 6.—The age of the B battery when put into service. All dry batteries lose energy when standing idle, some of them at a quicker rate than others. 7.—The personal factor that determines, not the life of the B battery, but how long you will use it, is your opinion as to when the concerts are too weak.

Vacuum Tubes in the Making.—Tube making requires great care and patience. There are thirteen steps or processes in production, all of which must be watched closely in order to assure a perfect finished product. A test is made after each step is completed and, of course, a test after the tube is complete. The manufacture of a tube is begun by spinning a flare on the end of a short glass tube. This tube is then called the "flare." Five wires are then inserted in the "flare." Looking at a WD-11, one can see five wires in the inner unit, although there are but four contacts at the base. The fifth wire is a blind insert to support the plate. The end of the "flare" is melted and pinched to imbed the five wires securely. This is now called the "press." The five wires are next cut to their proper lengths and the elements spot welded in place by expert girl operators. The filament used in the WD-11 is a platinum-iridium alloy coated with chemicals to increase the electronic emission. Now a small hole is melted into the glass "blank" or bulb of the tube to be, and a thin tube fused on its end. The "press" is then sealed to the bottom of this "blank" by welding with a gas flame. All air is then exhausted from the "blank" through the thin tube. This is done by inserting the glass tube into a piece of rubber tubing which in turn is connected to an exhaust pump. Before the pumps are turned on, a covering which serves as an oven is pulled down over the tubes and they are subjected to a temperature of 400 degrees Centigrade to drive all gases from the glass walls and metal parts. While the exhausting is going on the plates are heated red-hot to remove the gases from the metal plates and supports. The pumps are turned off and a gas flame run around the bottom of the long glass tube until it melts off and forms the tip of the vacuum tube. The tube is now complete except for the base which is baked on by machine, the tips neatly soldered, and

"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"



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For a "B" Battery use the familiar standard 22½-volt Eveready "B" Battery No. 766. It has variable taps for "soft" detector tubes. Put two, three or four in series to provide sufficient power for amplifying tubes.

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It is advisable to use two Eveready "A's" connected in multiple for each WD-11 or WD-12 tube—this gives the "economical eighth" ampere drain per cell which insures maximum economy and longer life. For sets employing from one to three UV-199 tubes use three Eveready Dry Cell Radio "A" Batteries No. 7111 connected in series.

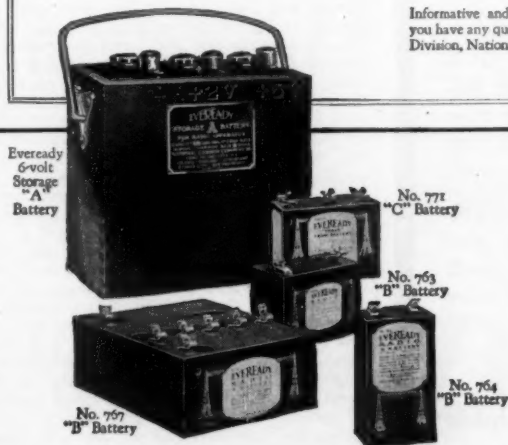
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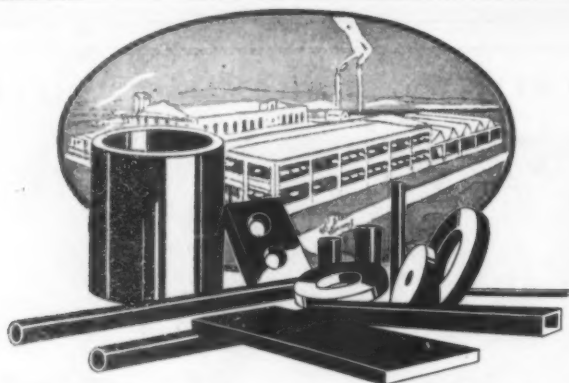
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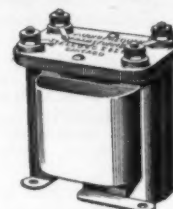
the tubes tested under conditions similar to actual receiving.

Man-Made Static.—With the extensive use of super-sensitive radio receivers, radio listeners are more and more subject to all kinds of disturbances which heretofore, because of the relatively insensitive circuits in use, would have passed unnoticed. Thus our super-sensitive radio receivers now pick up the make-and-break effect in an electric light circuit, the arcing of the trolley-car wheel on the trolley wire, the leakage from a faulty power transformer, the vibrating reed of the storage battery recharger, and so on. Although the electrified railroad is almost a mile distant, the writer of these lines has noticed an overwhelming avalanche of man-made static when sleet forms on the third rail and causes improper contact between rail and contact shoes. The writer has found it impossible to operate his set when an automatic traffic lamp, at the other end of the town, was not functioning properly; indeed, radio in the town was entirely demoralized until the source of the trouble was located and rectified. Old timers who can recall the days of the cumbersome tuning coil and the troublesome crystal detector, will tell you that they never heard such static back in the pioneer days. The truth of the matter is that there were just as many causes for static disturbance as today, but the relatively insensitive receivers of those days never picked up such minute electromagnetic disturbances. It was only when an electric storm hove into view, generally speaking, that heavy static disturbances were recorded. All of which causes us to wonder whether, after all, the development of the super-sensitive receiver is the best procedure for the future of radio broadcasting. The more sensitive the receiver, the greater the "parasites" or extraneous electromagnetic wave disturbances. After all is said and done, the real solution of better broadcasting lies in more powerful broadcast transmitters brought nearer to the radio audience by a vast system of repeater stations.

The Case for the Regenerative Receiver is again presented, this time by that well-known radio engineer and manufacturer, Mr. C. D. Tuska of Hartford, Conn. "Radiation from receiving sets, a brand new type of interference," states Mr. Tuska, "is creeping out and is becoming very serious. Probably 90 per cent of the present receiver interference is due to improper and careless operation. Radiation from a receiving set improperly handled is the cause of squeals and howls in other receivers in the neighborhood. In general, all present-day receivers (regenerative, radio frequency and most of the 'dynes') have at least two control knobs. One of these knobs generally covers wave lengths, while the other, no matter what it is labeled, covers regeneration. Regeneration is the building up, reinforcing, or amplifying of received signals within the vacuum tubes. Regeneration carried too far causes the vacuum tube to sustain these amplified or reinforced signals, and results in the generation of radio frequency currents. This is called oscillation. Regeneration, up to the point of oscillation, will never cause any interference. What happens is that the regeneration is carried a few steps too far and the receiving tube starts to radiate waves corresponding to the length at which the tuning controls are set. The receiving set becomes a transmitting outfit. How to make a novice distinguish between regeneration and oscillation is not an obvious affair. I would recommend that those of you who have receiving sets and do not know, take this suggestion and try it out on your own set: Set the wave length dial and bring the regeneration up from the zero to the maximum position. As the regeneration is increased, using the right hand to turn the control, tap the wire leading to the grid of the detector, with the left hand. When the tube is exceeding the regenerative point and has broken into oscillation, you will hear a click or two clicks as you tap the grid connection. Sometimes you can get the same effect by tapping the aerial binding post, but the grid is the only reliable contact. Tune your set with both hands at one time. With the left hand turn the wave length control a degree or two and then use the other dial (regeneration) with the right hand, carefully bringing up this dial to the critical point of 'maximum regeneration.' This point may easily be distinguished after a little experience by the nature of the sounds in your loud speaker or phones. If you have gone too far in regeneration, the received signals will sound mushy. Back down the regeneration dial. Then leave it alone."

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Taking the Stenches Out of Industry

(Continued from page 429)

ent deodorants, and found that hypochlorite of soda, made by electrically decomposing salt brine, would turn a fishing vessel sweet and clean, and keep it so. This chemical is cheap, non-poisonous, and can be made on fishing vessels with fairly simple apparatus. When enough of it is dissolved in a fishing vessel's bilges, they are completely deodorized and become fairly clear. A ship can be kept sweet without tearing up decks, removing ballast, whitewashing or any of the other expensive measures formerly necessary, for whenever *eau de bilge* develops it can be eliminated with more of this chemical. Fish odors around markets, piers and storage places are eliminated by using it as a spray or in the cleaning water.

Industrial smells are bad business. They create public resentment, bringing the health authorities down upon the offending industry with hampering restrictions, and stigmatize it as a nuisance. And the food industries, having had more than their share of offensive smells, have also suffered from popular suspicion.

Therefore, now that ways are being found to take the perfume out of industry, there will be little delay in applying them. The manufacturer is just as keen about it as the community. For where the latter suffers chiefly in its sense of smell, he has been suffering in his pocketbook.

Telepathy and Radio

(Continued from page 382)

choice of the reading; and one might imagine that it would be free from any psychological dictation of the answer. The returns contradict the latter supposition, however; 49 answers out of 473 hit upon the hours of three or four o'clock, while 3.45 and nine o'clock scored eleven each. Perhaps the psychologist will analyze this, and tell us just why the preferences indicated are shown. The correct hour of 1.10, by the way, was given by three people; while it may or may not be significant that the respondent who had more correct replies than any other came very close here, naming the hour of 1.15.

No less than 94 answers involved readings that were not even multiples of the five-minute unit. This would have embarrassed us if we had felt obliged to calculate the mathematical probabilities, since in the one event there are 720 possible answers and in the other only 144. Until better data are available, perhaps the psychologist will consider that this test indicates that, when asked to name an hour at random, 25 per cent of the human race will name an even hour, 30 per cent additional an even quarter or half-hour, 25 per cent more an exact multiple of five minutes, and the remaining 20 per cent an odd minute. One faithful soul even split his minutes, and reported 8.47½.

Keys—and Other Things

The sixth test involved identification of a specific object which I held in my hand, and which was described in no further detail than that. Three people out of 461 correctly named it as a key. No calculation of probabilities is possible; for we don't know how many different objects might have been named, and we couldn't weigh the psychological factors very accurately. That these were large is proved by the fact that about 200 people named an object that, consciously or subconsciously, was suggested to them by the idea that I had got it out of my pocket as I spoke. There were 55 pencils, 37 watches, 34 pocket knives, 22 coins of one sort or another, 21 fountain pens. Outside the group of pocket pieces, the most popular guesses were a book (40), an apple (29), a ball or something else involving the idea of sphericity (17), a block, cube, square piece of wood, etc., (13), a paperweight (12), a hat (11), a stone (10), an orange (10). In all, eighty different objects were mentioned. A number of people were, consciously or otherwise, trying to outguess me, with such selections as a cabbage, a doll, a flower pot, etc. The two who said a silo and a cow had not, presumably, heard me say that I held the object in my hand.

Test No. 7 was based upon an advertisement from the Sunday paper; the identification of the product was asked, by kind rather than by specific trade name. Of 459 replies, 14 named the article correctly as a dentifrice. Now tooth pastes are advertised, but not nearly so freely as automobiles and a lot of other things—and one whose

mind turned toward the bathroom would, I think, strike on the soap first. I should have been prepared to find considerably less hits here. Still, 14 of my audience may have just been brushing their teeth! Perhaps we may say of this test, alone, that it makes it difficult to conclude with certainty that telepathy was not at work.

The final number on the program was a very dramatic picture of a cross-country run. It was described merely as of a sporting event, and the audience were asked for further details. Of 465 replies, nine indicated a foot race or even a cross-country run; and six others said just a race, without indicating whether they had men or horses in mind. Baseball, golf and boxing got a heavy preponderance of the votes, indicating that this test was largely answered on psychological grounds dictated by personal interest and the season. Devotees of mah jong will perhaps be gratified that in the opinion of several members of the radio audience, this pastime qualifies as a sporting event.

The Critical Test

The fifth test will take a lot of discussion. For it, as nearly as I can reproduce the exact words, the announcement was:

"On the next test I must give you a little more time, and I must take a little more myself to explain what is wanted. You will recall that when you were very young you used to draw human figures in simple outline—a circle for the head, an ellipse for the body, four straight or bent lines for arms and legs. We have before us in the studio four sketches of this character, each engaged in some definite action or standing in some definite position. These actions and positions are such as can be easily drawn, easily recognized, and easily described. Please try to reproduce the four sketches, or write down words indicating what they represent."

In drawing the originals during an idle moment of the afternoon, I had set them rapidly down in a row, without any particular mental effort—just letting them flow off my pencil as they flowed into my mind. They represented, in order, a man waving a flag; running; standing on his head; and kicking a football. I had intended to tell the audience that they might insert such accessories (flag, football, etc.) as were required by what they had in mind; but I refrained from this as being too strongly suggestive. Plenty of them did it, anyhow.

It is important to observe that any argument about the psychological probabilities which we may apply to the returns, attaches equally to my originals; my mental processes in drawing these were, presumably, quite the same as those of the non-telepathic respondents—who of course constituted a majority, at least, of my audience.

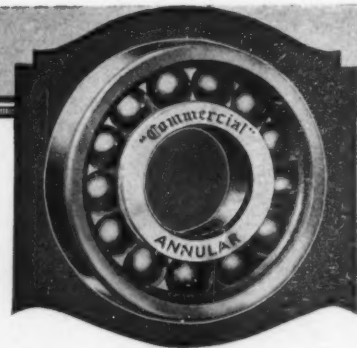
On this test, 403 people drew four figures. Seven more drew single figures only, which were scored as pertaining to test 5A. On this test, ten scored successes in whole or in part. Eight people drew a man waving an unmistakable flag—two drawing him first, and six in some other rank. Two left it doubtful whether it were a flag or something else—a hatchet, particularly; one of these had him in the right order and one in the wrong. For scoring purposes, Dr. Murphy and I agreed that those who drew the figure correctly but in the wrong order ought to get full credit. On 5A we gave half credit for a doubtful flag; this made eight successes and two partial successes out of 410 returns—neither positive enough nor negative enough to get excited about.

The returns for the other three little figures, however, were decidedly exciting. Of 403 people answering these three, no less than 100 drew a man running—27 getting him correctly in second place and 73 in other orders. Of the same 403 people, 25 drew a man standing on his head—14 correctly in third place, 11 in some other place. And 25 of them did something with the kicking man. We recognized 11 complete successes, where the little figure was actually kicking a ball; and 14 partial successes, where he was just kicking the air. Of the 11, four were in order and seven out; of the 14, one was in order and 13 out.

Accident, Psychology—or Telepathy?

This raises several critical questions. The mere score seems high, not alone on the running man, but also on the inverted man and on the kicking man. Indeed, looking at the thing psychologically, the running man is perhaps less alarming than the other two. When I ask for a man engaged in some definite action, inevitably, I turn my listeners' thoughts away from a man standing still; and if he isn't standing still, what more

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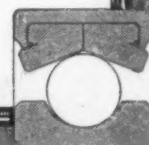
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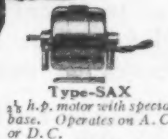
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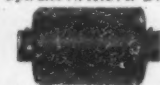
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natural to think of, what more ridiculously easy to draw, than a man running? It really seems as though 100 instances of this choice are more to be expected than 25 cases where my listeners give a man on his head, or a man kicking.

Then the man on his head gives us another large metaphorical mouthful to chew on. On the other three sketches, 119 more or less correct replies included 33 in the right order and 86 in the wrong—a mere 28 per cent being in the right place. But on the man upside down, no less than 56 per cent of the correct answers are in the correct order. Can it be possible that this is accident, or psychology?

Our first attempt to explain it as psychology seemed, rather, to make sense. We argued substantially to this effect:

Confronted with the demand to draw four human figures in action, the average person will probably exercise considerable ingenuity and originality on the first one, and will then relapse into a quick-and-easy, natural choice on the second. Or he will make the quick-and-easy choice first, and the ingenious one second. In either event, having been natural, and drawn a running man; and having been ingenious, and drawn a man waving a flag, or something of comparable unusualness—he will be at a temporary loss for a third alternative, and will reach this only after a process of more or less conscious and deliberate search. Undertaking this search, what more logical or psychological than that he should turn the figure upside down? Certainly, having made a choice for three of my originals which falls in with this argument, I am in no position to refute it. The only refutation—for that matter, the only verification—would lie in specific tests. So Dr. Murphy and I, individually and collectively, attempted a series of tests, designed to learn what would be the response of the human animal, in general, to the demand that he draw four of these little figures.

This test was made upon six groups, of students in some cases and office workers in others, and under conditions that were purposely varied; but always with the effort to describe what was wanted in the words I had used in the original radio test. The control test was applied, in all, to 163 persons. The variation of conditions had no effect that I can see, and for that reason, I shorten the discussion by ignoring it, ignoring the separate groups tested, and giving the results in a lump.

Of the 163 subjects, only three drew a man waving a flag; and all three put him in first place, the position he occupied in the original test. Thirty-four drew a man running; seven putting him in second place as on the radio test, while 17 put him in first place. That is to say, 24 followed the psychological argument advanced to account for the large number of runners; of the remaining ten, six had the runner third and four had him fourth. Only five of the 163 control subjects drew the man on his head; one put him in third place as on the radio test, two in fourth place, one each in first and second place. Six drew a man kicking a ball (one in fourth place as over the radio; three first, and two third); while six others drew the kicker without the ball (again one in fourth place; two first, three third).

Test vs. Control

Comparing with the radio results, we find that 1½ per cent of the radio subjects scored a full success on the flag-waver, with two per cent scoring some measure of success; while of the control subjects, two per cent scored a complete success, and none a partial one. Obviously there is no evidence that the telepathy test brought out any telepathy, on this item.

Of the radio audience and equally of the test subjects, 21 per cent were successful with the running man. Six per cent of the radio subjects put him in the same place that I had put him in, and only four per cent of the control subjects followed me here. This divergence would be of doubtful significance, even if repeated for several tests; on the single test it meant nothing at all. Again we have no justification to infer that telepathy was at work.

Of the radio audience, six per cent drew a kicking man, with about three per cent giving him a ball to kick; while slightly more than one per cent put him in fourth place, as I had done. Of the control subjects, 7½ per cent drew the kicker, and again about half of them gave him a ball to kick, with little more than one per cent placing him fourth. So again, significant as it

seemed at first glance that this test might be, there is nothing here.

Six per cent of the radio fans drew a man on his head; 3½ per cent of them correctly put him in third place. Of the control subjects, only three per cent got him in at all and less than one per cent got him in third place. Here we have the one result which makes it possible to suggest that telepathy may have been at work. Of course such an explanation would be hasty from one test; but at least, in this one instance from the twelve there is something left to explain.

Analysis may take one further turn. If certain individuals among the audience were displaying any tendency toward telepathy, we should expect them to be right, in the long run, more often than the bulk of the respondents. We can try this out very nicely by looking at the 41 respondents who got more than one item right or partly right. Did they score more consistently with their second successes than the bulk of the subjects scored with their first and only successes?

To answer this we must have a figure representing the probability of getting each question right; and in this, as we have seen, psychological considerations enter which we cannot evaluate accurately. We dodge this by assuming that, for purposes of dealing with this test, the correct probability on each question is represented by the performance. If 78 of our respondents out of 448 have the Times test right, we assume that the probabilities of getting it right, for this audience, are 78 in 448, or 1 in 5.74. This puts us on a solid basis.

Under this convention, since nobody got the first question right, the probability of getting it right is zero; so we omit it from the argument entirely, and proceed as though the remaining eleven items constituted the entire series.

Let us take the Times test again. When we know what the separate probabilities are for getting each of the remaining ten tests right, we know automatically what the probabilities are for getting each wrong. We can calculate from this the chance of getting them all wrong. But knowing this, we know the probability of not getting them all wrong—which is to say, the probability of getting one (or more) of them right. This figure applies equally to those who got the Times test right and to those who got it wrong—so far as guessing the answers is concerned. But if any or all of those who got the Times right show a tendency toward telepathy, they ought to better the probability for the remaining tests. And the same argument applies with each single test, and each residual group of ten other tests. Of those who answer any question correctly, we can always say how many ought to be right on something else. If performance exceeds these figures, we may fairly suspect telepathy of responsibility for the unearned increment.

The Final Angle

Of those who got tests 2, 3A, 3B, 4, 5A, 5B, 5D, 6, 7 or 8 right, the table of page 382 makes it plain that in no single instance was the percentage scoring a second success greater than the percentage of the general herd who scored a single success in one of the remaining tests. Equally for the general case, this table shows that those who got anything at all right did not score second successes any more freely than the general herd scored first successes. Indeed, on most of the individual tests and on the general case, the group who had got one item right did not even do so well as did the common herd.

But to all this there stands one conspicuous exception. Of those who got the man-on-his-head of Test 5C right, only 11, on pure chance, were entitled to get anything else right. In point of fact, 16 got something else right. The slight possible significance which this single observation would ordinarily possess is considerably enhanced by the fact that it was this very test which, on its own grounds, gave us reason for suspecting that telepathy might have been at work. There is absolutely no dependence between examination of the returns in these two ways—absolutely no inherent reason why the test that shows up strongly from the one angle should show up strongly from the other. That this test does exactly this is possibly significant, and certainly of extraordinary interest. As regards definite conclusions, of course, there is "nothing to say" until further tests have been made. These will proceed as rapidly as possible; some being made as was the first one, with such improvements in tech-



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nique as experience suggests, and others being made in a less promiscuous fashion with those of our high scorers from the first test who display willingness to give us a little of their time. There are enough who got complete or partial successes on three separate items to make the hunt through the list for real telepathists quite worth while.

Coal and Coal Tar

(Continued from page 390)

used in enormous quantities during the war and which is also of some importance as a commercial explosive. It forms the starting point for the manufacture of a large number of intermediates which are used in making various dyes and drugs. Xylene is also used for similar purposes. Naphthalene is the ordinary tar camphor, which is used to combat the moth in its depredations on clothing. It is also used in preserving hides. It is estimated that the potential naphthalene in the coal tars produced in America, is probably far in excess of 100,000,000 pounds a year. The crude carbolic oils, phenol and the cresols are used for many purposes in preparing disinfectants, sheep dips, flotation oils (oils used in separating the metallic constituents from the gangue in ores), manufacture of synthetic tanning materials, dyes, perfumes, photographic developers, explosives, pharmaceuticals, etc.

Anthracene is used as the starting point in making alizarin and vat dyes. The pitch, that forms the residue, is employed in making roofing felts, paints, as binders in making molds for casting steel and other metals, as binders in briquetting coal dust, waterproofing dams and concrete in general and for many other purposes. In recent years certain of the higher-boiling-point fractions of coal tar have been utilized for the manufacture of lubricants used as substitutes for mineral lubricating oils and greases. The Germans developed this industry during the war when short of mineral lubricants.

During the war, when the demand for benzene and toluene was very great for the manufacture of military explosives, processes for scrubbing these products out of illuminating gas were developed. To-day practically all of the benzene and toluene recovered in gas manufacture is scrubbed out of the gas, and the tar that is obtained accordingly contains very little of these constituents.

It has been shown that coal is burnt in the furnace and stove to produce heat and power. No matter what the fuel is, whether it be a liquid or a solid, it must first be converted into the gaseous condition before it can produce heat. Thus every kitchen stove or steam furnace is a small gas producer, whose efficiency is low compared with the gas-generating apparatus in the gas plant. The efficiency of an average steam furnace is only about 50 per cent, while that of a gas-generating plant is 85 and even 90 per cent on the thermal basis. The logical conclusion is first to convert the coal into gas at the gas plant and then to burn the gas in the place of coal.

The time is undoubtedly coming when coal will be supplanted as the common fuel, for the waste in heat and valuable by-products, that ensues when it is burnt in the stove, steam furnace or under the power boiler, is too great to go on indefinitely. What the fuel of the future will be will depend on how economically and efficiently it can be made and distributed from the place of manufacture to the consumers. Everything points to gas as the permanent fuel of the future. It is possible that the gas will be produced right at the coal mine and distributed through a system of pipe lines, much like the present oil pipe lines. The coke produced will then be consumed for metallurgical purposes, or itself converted into more gas, the by-products collected and manufactured into valuable substances and the gas alone used as a fuel.

In our country, with its large natural resources, with its apparently limitless supplies of coal, iron and other essential commodities, the moment of exhaustion of these supplies seems far in the future. But that moment is surely approaching and even now we hear estimates made of the day on which our oil resources will be exhausted. It is time now to give a thought to the future. Coal will not always be so plentiful, and if we have learned anything from our experiences during the past years' coal shortage, we must have formed some idea of a time when there will be no coal and of the dire things that could happen then if we do not prepare now to develop other fuels to take its place.

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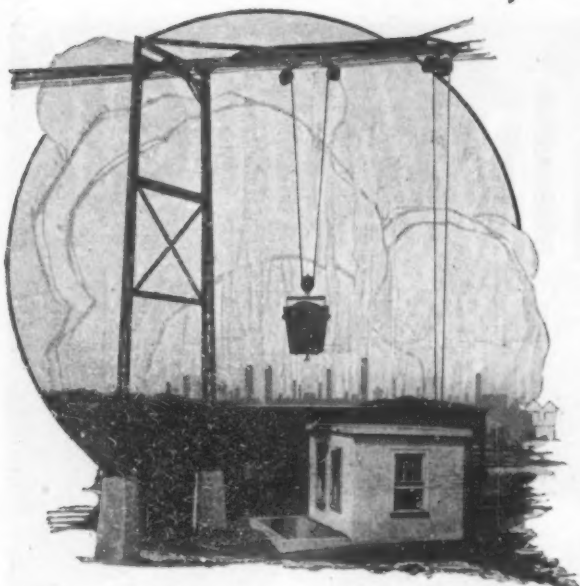
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Our Abrams Investigation—IX

(Continued from page 383)

to time to follow the progress of the tests, but no one else saw it until the end.

For Series I, Mr. Lescarboursa served as reagent. While working with the fourth specimen, the reactions became “tired” and the Series was suspended. It was intended to return to it later; but examination of the three sets of readings obtained made it plain that these three specimens must be adjudged identical—if the readings for the remaining specimens did not diverge from these, the test would be worse than a failure, in that it would not discriminate at all between the specimens. The three specimens thus associated were numbers 1, 4 and 5; the identical specimens were 1, 2 and 5. The Series was considered as completed, and scored as a semi-success.

For Series II one of the physicians acted as reagent. The readings for specimens 2 and 3 were very closely parallel. After some discussion, it was decided that of the other four, number 4 got closest to these two. The identical specimens being as in Series I, Series II was therefore a total failure.

After four specimens had been tested in Series III, using an attaché of the doctor's office as reagent, the reactions were completely “exhausted” and the test had to be terminated. It was plain that no two of the four specimens tested could be pronounced identical. Since the two remaining untested might have come out as identical with any one of these, this Series could not be rated at all. Its readings, however, are available for checking against those of Series I and II, for which the same specimens were used, and in the second table on page 383 they are displayed and used for that purpose.

In Series IV, a young lady attendant was the reagent. The identical specimens were 3, 4 and 5. It was difficult to choose between 2, 4, 5 and 6 on the basis of the readings obtained; the most plausible selection seems to involve the throwing out of the fourth specimen, on the ground of the low reading for rate 60. The test then becomes a total failure.

Of Series V, made with Mr. Lescarboursa as reagent, no three of the specimens stand out as in any way probably identical; and attempting to force a choice, the physicians could reach no agreement as between the three combinations 1, 4, 5; 2, 3, 4; 3, 4, 6. Two of these combinations are wholly wrong and one partly wrong; the identical specimens were 1, 3, 6. Combined with the obvious failure of the test to make a clear distinction, this seems to warrant the verdict of total failure for Series V.

Series VI, one of the physicians as reagent, points fairly straight to specimens 1, 2, 5 as the identical ones. Made with the same specimens as Series V, this is another total miss.

Of five tests, four were complete failures and one a partial failure. This is very much worse than one should score with outright guessing. It would seem that the method employed was sufficiently discredited by these findings; but if we arrange the returns a little differently, we must grant that the performance attained in these tests looks even worse.

In Series I, II and III combined, six sets of readings, in all, were made upon specimens of identical origin. Series IV gives us three such readings; and Series V and VI together give us six. If there is anything at all in the electronic diagnosis, the readings ought to agree fairly well within each of these three sets. It is putting it very mildly indeed to say that they fail wholly to do this.

For rate 57 on the samples of the first day, readings run from 4 to 44; and they are quite evenly distributed through this interval. They are so scattered that it is idle even to talk about averaging them; the average of 4, 13, 21, 22, 23 and 44 is quite without mathematical significance. Similarly, rate 55 runs the gamut from 0 through 4 to 11. What would we say of a scientist in any field whatever who couldn't determine the correct reading, in degrees or volts or centimeters or grams or seconds or what-you-will, any more accurately or consistently than this? What would we say of him if, in response to a straight yes-and-no proposition, he gave us three yesses and three noes, as these rates do when asked the sex of this subject? What would we think of him if, after this showing, he continued to use, with apparent confidence, the method by which he had reached these extraordinary findings?

Rate 55 for the six readings of the third

day is another particularly damning thing. For that matter, rate 57 on this day is a most extraordinary exhibit, if offered in support of the technique under which the readings are made; three answers slightly above 20, and three more slightly in excess of 30, are pretty crude. And what of rate 55 on the second day? or rate 60 for this day? or rates 42 and 60 for the final day? Isn't the answer pretty obvious? Can we possibly believe that this technique is anything more than subconsciously directed guess?

Of course, if the electronist were diagnosing a patient from one of these specimens, the chances of contamination, etc., etc., etc., would be considerably greater than in our carefully conducted tests, with their elaborate ritual. But in that case nothing would be said throwing question upon the results; while in the present instance, the electronist will protest and protest upon the grounds indicated. Just by way of letting him have his way, let's turn, then, to the readings for the individual samples. Surely he can not, without losing his face entirely, claim that two tests made, in quick succession, upon the very same sample, may diverge seriously and properly and without embarrassment to the Abrams claims.

On the first day, specimen 1 gives readings of 22 and 44 for rate 57; 0 and 11 for rate 55; 0 and 6 for rate 58. Specimens 1 and 2 of the third day show an alarming variation in rate 55. Among the single, isolated specimens, there is even more of this sort of thing. On the first day, specimen 3 gives 4 and 13 for rate 57; specimen 4 gives 14 and 24, 2 and 15, male and female, for the same rates; specimen 6 gives five discrepancies that run all the way from 200 to 1800 per cent. Though this might well set the climax, we must still direct the reader's eye to the readings of Series V and VI, with 21 matched against 32 and 34, 2 against 11, 3 against 23, 7 against 3—and all three of the specimens contradicting themselves on rate 49! It would certainly be fair to remark that, if these rates correspond to anything in the pathology or physiology of the subject from whom the blood was taken, we should hardly expect that two individuals taken at random would exhibit such wide discrepancies, in general, as do these specimens taken from the same person.

The showing would be far worse, were it not for the objectionable lowness of the readings. Were it pretended that they are at all minutely accurate, this would not be so bad. Readings of 0 and 1, of 1 and 2, etc., can be compared, easily enough, if only we know that 0 means 0 and 1 means 1 and 2 means 2. But when it is understood to begin with that all that any of these readings mean is “low,” they cannot be intelligently compared. Let us see just what a little mathematical conventionalizing will do to discount this inconvenience.

Where at least one of the readings for a given rate exceeds 5, we can make intelligent comparison. Confining ourselves to readings from the same single specimen, there are 29 such comparisons to be made from the appended tables; and of these, only five show reasonable agreement between figures which should be identical, the other 24 diverging. If we extend the comparison to cover all samples from the same subject, the number of comparisons which we may make is increased to 72; and 18 of them are reasonably close, while the remaining 54 are in discord. Surely this is a most disreputable showing for a procedure which is claimed to be from 80 to 90 per cent right—when we are not watching; and which is used by its supporters as a basis for discrediting the standard clinical diagnosis.

The straight yes-and-no proposition of rate 49 gives us another dreadful showing. Confining our attention to individual specimens, fifteen independent comparisons are possible; and of these five are in agreement and ten in disagreement. If we permit ourselves to compare distinct specimens from the same individual as well, we get a total of 41 comparisons, of which 17 check and 24 refuse to check. If frankly guessing, we ought to be right on this 50-50 question exactly half the time. And here, where we are alleged to be doing something better than guessing, we must be right considerably more than half the time—instead of which, we are wrong practically two-thirds of the time.

Here, then, is a scientific test of E. R. A. which cannot be repudiated without serious complications, since the doctors who collaborated with us in this series of tests are the sponsors of a well-known and widely circulated report which endorses the basic claims of Dr. Abrams.

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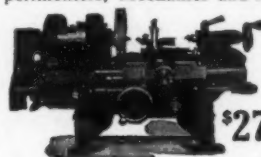
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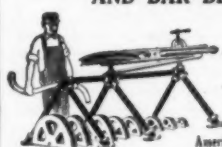


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The Blast Factory

(Continued from page 386)

to an overhead belt drive. The various dry ingredients—nitrate of ammonia, nitrate of soda, wood pulp, cornstarch, ivory nut meal, chalk and sulfur, for ammonia dynamite for instance—which have been previously weighed out and screened together in the proportions called for by the formula, are poured into the bowl and the wheels are driven two or three turns to level the heap down. Then the nitroglycerin is slowly run in through a rubber tube from the buggy and the machines are started. As the wheels revolve, an inner and an outer plow attached to each keeps throwing the powder from the sides of the bowl back under the wheels so that it will be thoroughly mixed. The mixture, much like brown sugar in appearance, but feeling a trifle oily, is the finished dynamite and it is henceforth treated with the respect due a high explosive. Every crumb thrown on the floor by the revolving wheels is carefully swept up lest it be stepped on and explode with sufficient violence to set off the whole mixing. Here, as in the nitrating house, the machine seems to dominate. The men move about quietly in their rubber soled shoes, silent, as if listening for the slightest irregularity in its motion, the stillness and the care and precision of their movements as they tend the machine suggesting a ritual and creating a feeling almost religious. When the mixing has continued for a stated time, fixed by the laboratory for each kind of dynamite and measured by a sand glass, the mixers are stopped and the dynamite is shovelled out with wooden shovels into wooden boxes and sent to the packing house. The process of mixing straight dynamites is the same as that used for ammonia dynamites, the difference being that the former contain a larger percentage of nitroglycerin and no nitrate of ammonia.

At the cartridge packing house the bulk dynamite meets the paper shells which have been made in the shell house and sprayed with hot paraffin to waterproof them, and a very ingenious machine packs the explosive into the shells. The dynamite is dumped on an inclined conveyor which feeds it into a hopper at the top of the machine, while the paper shells are fed automatically into a revolving drum beneath the hopper. A battery of tamps operated by a friction drive rise and fall in the shells until the powder is packed to a uniform density. As soon as one row of cartridges is packed full, the drum automatically revolves, bringing another row of empty shells under the tamps, while the open ends of the filled shells are folded over and the finished cartridges are dropped into a trough from which the operator gathers them up to stand them on end in crates.

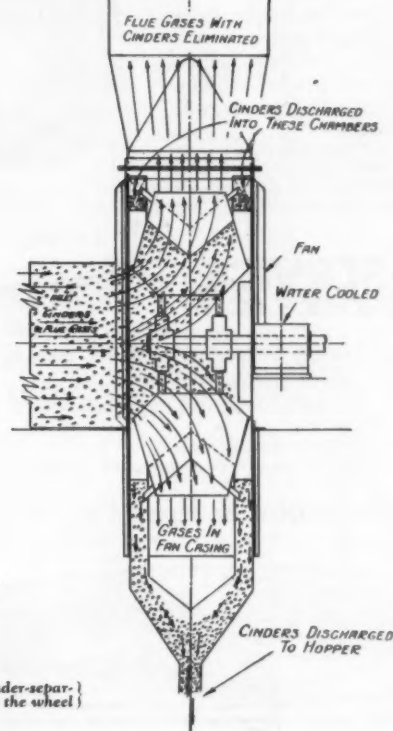
The processes of mixing and packing gelatin dynamite differ somewhat from those employed for the types which are of a granular consistency. The gelatin mixing machine consists of a bronze bowl, shaped like an oval and supplied with a hot-water jacket and with two paddles operated by an electric motor. The nitroglycerin is run into the bowl, a small percentage of nitrated cotton is added and the paddles are started. The nitroglycerin is gelatinized by the nitrocellulose and this gives the dynamite plasticity and water resisting power. The dry ingredients, similar to those used in other types of dynamite, which have been previously sieved together, are next poured in and the agitation is continued until the mixture becomes uniform and reaches the proper degree of plasticity. To determine this point demands the nicest judgment, for while on one hand the degree of gelatinization directly affects the efficiency of the dynamite, on the other, science has never yet been able to fix a time and temperature for mixing which would yield a uniform product from different mixings. The gelatin foreman must decide when to stop the agitation according to the look and feel of the dynamite.

In the gelatin packing houses, the plastic mass is fed into the hopper of the packing machine and a revolving worm in the hopper squeezes it out through multiple nipples into the paper shells held in shuttles on a turntable below.

The crates of cartridges from the cartridge packing houses are transported to box packing houses and dipped into a vat of hot paraffine. The cartridges are then packed by hand into wooden boxes—25 or 50 pounds net weight—which are either loaded at once into freight cars or stored in a magazine until needed for shipment.

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mines to furnish the energy for breaking down coal and for getting out the ores from which are derived iron, steel, copper, lead, zinc, gold, silver—all the metals; into the quarries where it is used to blast stone for flux in the ore furnaces, for grinding into cement, and for building railroads and highways and jetties and breakwaters; into great construction operations where it is employed to dig canals, excavate foundations for buildings, drive tunnels through the solid rock and cut roadbeds along steep mountainsides; into the cutover lands of the Northwest and the swamps of the south where it blasts ditches to drain the land or clear it of stumps so that it can be put under cultivation, for all these industries and the commodities which they make possible are inseparably linked with the manufacture of dynamite.

Studying Fire Risk from Sample Fires

(Continued from page 388)

Nothing especially new in this. But it seemed advisable to study what was going on during the period of slow crushing. It was ultimately found that at the ends and at certain short distances from the ends moderate temperatures brought about a softened—almost a plastic—condition. After this discovery, efforts were made to devise a protective cap for the ends of wooden columns. This has been carried so far that a series of tests has resulted in showing that a wooden column may be so installed as to endure the fire test for one and one-half hours instead of thirty minutes. In all cases in this series, the column failed in the body portion and not at the ends.

It will be gathered perhaps from the foregoing examples that the investigations are producing a new fund of information—useful to insurance companies, owners and builders.

What are called "fire windows"—that is, windows capable of withstanding fire, heat and water—cannot, in the nature of the case, be made equal to high degrees of exposure. Light must pass through the glass—otherwise the window is no window at all. This means also that more or less heat will go through. Then the glass softens and falls out, even wired glass being subject to such failure. However, there is such a thing as a "fire window" capable of affording a useful amount of protection. Such windows have been developed, it seems, largely in consequence of experiments made by way of test. The window will be exposed, say, to a multitude of gas burners. Early in the test, as the wired glass absorbs the great heat, there will be a series of reports and a network of cracks will spread over the window. The advantage of the wiring becomes clear, since the wires maintain the cracked glass for a period. In one of the views is shown a wired glass window with metal frame which has undergone nearly one hour of exposure to flames.

Criticisms of Our Article "More Steam-Engine Power Without Steam"

IN the March, 1924, issue of the SCIENTIFIC AMERICAN there appeared an article entitled "More Steam-Engine Power Without Steam," which attracted a good deal of attention and, we are sorry to state, a good deal of criticism. From time to time there appear certain substitutes for water and steam for use in the usual steam boiler and engine, for which elaborate claims are made. In this instance, our Chemical Editor, Mr. Ismar Ginsberg, was sent to Philadelphia for the purpose of investigating the latest of these steam substitutes. Mr. Ginsberg was highly impressed with what he saw, together with the data supplied him by the inventors. Once we were convinced that the inventors in this instance were sincere and, seemingly, practical, we opened our columns to a short description of what they had done. We happen to know the composition of the secret liquid, but cannot make public mention of same for obvious reasons.

Many have been the criticisms received with regard to this article. However, that from the Bureau of Standards, which we quote below, is sufficiently representative to serve the present purpose.

"It seems appropriate that the Bureau should offer some comment as requested in your letter of April 10th, on the article 'More Steam-Power Without Steam,' appearing in the March, 1924, issue of the SCIENTIFIC AMERICAN, in view of the fact that from the manner in which the Bureau is referred to in the article many readers

would infer at least a tacit endorsement of the claims of the inventor and promoter. Except for this fact, the Bureau would have no occasion for official comment.

"As far as the reference to the Bureau is concerned it can be said that the statement that tests of the 'mysterious liquid' had been made is entirely incorrect. The Bureau answers thousands of miscellaneous inquiries each year, and it is quite possible that some information, drawn from available data, was furnished upon request.

"In reference to the article in general, and the claims set forth in it, it may be said that the fact that liquids of low boiling point, such as the one which is the subject of the article, develop considerable pressure when heated to moderate temperatures in a closed vessel, has frequently misled inventors into believing that power could be developed more efficiently by the use of such liquids than by the use of steam. It is, however, a direct consequence of the second law of thermodynamics that efficiency in power production is promoted by the use of high temperature in the boiler, and consequently, other things being equal, the liquid which at a given temperature, has the lower vapor pressure, will yield the higher efficiency. The development of the mercury turbine, which is mentioned in the article, involves a practical application of the facts stated above.

"As for the evidence given in the article that the new liquid produces power more efficiently than steam, the demonstration might easily deceive the uninformed, but anyone at all familiar with power development would at once recognize the numerous flaws in the demonstration."

Condensed Milk

AN important report by Dr. Savage and Mr. Hunwicke on the manufacture, condition, bacteriology, and spoiling of commercial sweetened and unsweetened condensed milk has been issued by the Food Investigation Board (British) (Special Rep. No. 13). The changes in the condition of the milk as a result of its concentration are profound, and are not merely those caused by deprivation of water. It is, for example, a much worse conductor of heat than unconcentrated milk. While sporing aerobic bacilli are present in a considerable proportion of samples, decomposition and spoiling are nearly always due to non-sporing bacteria, particularly certain micrococci, which either survive the preliminary pasteurization of the raw milk in the course of manufacture, or after canning are admitted to the tins through minute leaks. The sources of bacterial contamination and multiplication are mainly from the original milk, from the air of the factory, and particularly from dirty pipes and apparatus.

The Sky by Day

(Continued from page 402)

of eternal cold. This is the region in which "shooting-stars" stage their displays.

But up in those regions where the last vestiges of the earth's atmosphere is dying away and that infinitude of frigid emptiness begins, there are still other phenomena to interest mankind. At altitudes as high as five hundred miles are the mighty auroral arcs. These restless shifting curtains, streaks and bands are the electrical effects of the heavenly stage, doubtless caused by electrons of particles projected from the sun. If so they are similar to vacuum-tube phenomena. Apparently they are related to the sun-spots and to terrestrial magnetism. The magnificent splendor of the aurora is a fitting ending to the day, for the beauty and scientific interest of the day-sky demands a splendid benediction.

The stars come out, and we pick out Saturn and Jupiter and others of our family. They are receiving light from our sun which is far below the horizon. We turn toward Polaris and see in our imagination the cycle of the heavens. We pick up our telescope and look at the other suns and see many stellar bodies come into being which were invisible to our unaided eyes. We wonder how many of these bodies still remain behind the veil as yet unpenetrated by the greatest instruments. We wonder if space is infinite and we form a conception of infinite space. I wonder if we do or if we can conceive this infinity!

We leave the question undecided. We know at least that another day is coming and with it is another procession of sky interests, ever-changing and ever-interesting; full of unanswered questions but each when answered revealing others still unanswered.

Fighting the Bed Bug

(Continued from page 392)

water, powder and liquids. But cleanliness and chemicals are only partly effective, and necessitate a constant, wearisome battle.

People are now thinking about this pest in a bigger way. The bed bug is really a community problem. Given the necessary public opinion, there is little doubt that communities would take steps to vanish the bed bug from their borders, just as community pride has vanished pests like the cattle tick. When public opinion grows up to this problem, then the sanitarian will begin extermination in a large-scale way, with poison gas and modern apparatus for using it.

Hydrocyanic acid gas is the ultimate weapon. Made by mixing the two deadly poisons, cyanide of potassium and sulfuric acid, it is so penetrating and deadly that the Department of Health of New York City now prohibits its use except under strict regulations. In the fumigation of homes, business premises and ships, people are occasionally killed accidentally—occupants not known to be in the infested area, or sometimes adjoining premises, and even exterminators caught off guard. It is so quick in its penetration and action that experts applying it must wear gas masks. Its danger is increased by the fact that it has no odor. Lately, Washington experimenters have mixed tear gas with hydrocyanic, so that it gives warning, but even in this form it is extremely hazardous.

Under the New York regulations, hydrocyanic can be applied only by qualified experts approved by the Board of Health and a separate permit must be obtained in each case where it is to be used. Great care must be taken to see that not only infested premises are vacant, but in apartment buildings the premises above, below and on each side. Warning signs must be posted at every entrance, and watchmen as well, the latter remaining until the work is done.

Something like \$3,000,000 yearly is spent in New York City alone to keep better-class apartments and houses free of bed bugs. More than one thousand professional exterminators are at work all the time, in most cases for property owners who engage them by the year. Whenever apartments are vacated, the exterminator treats them, and should the pest be brought in by new tenants, does his work again. Yet despite this care in a few sections where residence property values are highest, not even those sections are permanently rid of the pest, because it is constantly being brought in from other sections. A novel fact about the industry is that professional exterminators do a good deal of charity work, like physicians—Mr. Sameth's organization has undertaken gratis to keep several day nurseries free of insect pests to which they are peculiarly susceptible.

The bed bug has a money value of a negative kind. It is economical not to have him around. For in property free of this pest, the outlay for repairing, repapering, repainting and renovating is generally reduced. The architect nowadays gives serious thought to economy of operation in his building, whether it be an office structure, a great hotel, an apartment house or residence. The professional exterminator advises the architect to take the bed bug into account when planning apartments and homes, eliminating every possible refuge and breeding place in walls, molding, wainscoting, closets, plumbing and the like, and also providing a steel or concrete chamber on the roof of every apartment house and hotel, fire-proof and air-proof, a death chamber to which bedding, furniture, luggage or anything else can be taken for treatment with hydrocyanic gas without disturbing occupants.

Vermin are often the first tenants of a new building. The tearing down of the old building on the site displaces rats and mice, who seek homes in the new building as soon as they can establish themselves. Insects of various kinds, including the bed bug, are brought in with building materials from the mills and warehouses. Workmen likewise bring in pests. On this account, the present-day exterminator takes contracts for his services while the building is being erected, making inspection before the floors are laid and after they are down, when the plastering is done and at other stages of the work.

"A real beginning in the extermination of the bed bug and other household pests will be made when communities pass ordinances compelling it," says Mr. Sameth. "More than once public opinion has been brought to the point where the people of a community have seen the wisdom of tackling this problem in a big way, but in practically every

case the attack was made by appropriating public money for an educational "drive," with the outcome that funds were wasted, some being spent for extermination work along ineffective lines. An extermination ordinance would compel all property owners to bear the expense of eradication. They would thus have reason to make sure that they got value for their money, and sources of reinfection being cleaned up, there would be permanent benefits. Along with such an ordinance should go some system for examining and licensing exterminators, instead of simply hampering them with regulations that increase the cost of doing the work and put it beyond the reach of many householders and property owners."

Many ways have been devised for fighting rats, ranging from catching them alive with the aid of ferrets, as the old-fashioned rat catcher does, to the upsetting of sex balance, a method by which the animals are caught alive, the females killed and the male turned loose to fight each other and reduce breeding. Poisons, traps, electrocuting devices, and even "fly paper" that catches rats with bird lime, are in use. Mr. Sameth declares that they are all good with one shortcoming—that they seldom destroy rats and mice as fast as they can breed. The latest weapon is bacterial. Pasteur isolated the germ of a disease fatal to rodents but harmless to other animals and human beings. This was used with some success, being spread by baits that communicate the disease to the rats who ate them, they in turn infecting others. Bacteria generally require something approximating blood temperature to thrive. As originally used on baits, they lost their virulence, being affected by lower temperatures and atmospheric conditions. Mr. Sameth has devised a new procedure by which the bacteria are kept vigorous at the proper cultural temperature, and injected into live rats, which are then turned loose. Inoculated in this way, the animals are carriers of the disease in its most virulent form, so that one hundred and fifty infected rats turned loose at strategic points in a large railway terminal, where rat damage amounted to \$20,000 a year, resulted in reducing the damage to \$5 a year and the picking up of more than four thousand dead rats over a five-months' period. Along with the rats, a plague of fleas disappeared, for the flea in most of our large cities is almost invariably a warning that rats are growing beyond bounds. When both rats and fleas were gone, there was a brief plague of mice, which are generally kept down by rats, and increase when the latter disappear. In comparison with a rat plague, however, mice bring no great difficulties to the exterminator. They are eradicated by inoculation.

The Story of Steel—VI

(Continued from page 396)

started by the ore reactions. The heat is then worked until the carbon in the bath is approximately that required in finished steel. Tests are taken of the heat and broken, the fracture is examined and expert melters read the carbon.

When the heat is considered ready, a steel bar is thrust through the hole in one of the doors and the retaining plug in the rear of the furnace is knocked out, allowing the steel to run through a trough into a ladle, which has already been heated by gas to dry out all moisture in the lining. The steel is then purified by the addition of certain deoxidizers, such as ferro-silicon and manganese, the greater part of the manganese remaining in the steel in order to meet the desired specifications. The necessary carbon is added either in the form of finely granulated coal or of molten spiegeleisen—a high manganese iron containing sufficient carbon and manganese to give the desired results. The slag being lighter than the steel, floats on the surface and much of the slag runs over the side of the ladle into pits or boxes kept for that purpose.

At a signal from the melter a massive crane, electrically operated, is moved in front of the furnace, drops its arms under the lugs of the ladle, lifts it and carries the mass of molten steel weighing often as much as 100 tons to the pouring platform, where the retaining plug or stopper is lifted up and the steel, through this aperture in the bottom of the ladle, pours into cast iron ingot molds, these ingots varying in size and weight, according to the product into which they are to be rolled. In an average size heat of 60 to 75 tons, the ingots will weigh approximately three and one-half tons each and be about 20 inches by 22 inches at the bottom, 6 feet or slightly more in length and slightly tapering towards the top.

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INDEX TO VOLUME 130

Lack of space makes it impossible to give many cross-references, or to enter a given reference in more than one place. In every case the general subject should be sought, rather than the supposed specific title of the article. We call special attention to the classifications "Household Appliances," "Machines as Machine Tools," "Machines for Special Purposes," "Tools," etc., under which many items will be found whose location otherwise would be very puzzling. These groups may be examined item by item for a doubtful entry with much greater ease than can the entire alphabet. The short notes comprising the columns of text on the advertising pages, are not indexed separately, but only under the column headings. The asterisk (*) indicates that the article in question is illustrated.

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